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Analysis

An institutional theory of hydraulic fracturing policy

Robert Holahan [a,c,*], Gwen Arnold [b,c]

[a] Environmental Studies and Political Science, Binghamton University, P.O. Box 6000, Binghamton, NY 13902-6000, United States
[b] Department of Environmental Science and Policy, University of California, Davis, 1023 Wickson Hall, One Shields Ave, Davis, CA 95616, United States
[c] Affiliated Faculty, Ostrom Workshop in Political Theory and Policy Analysis, Bloomington, IN, United States

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ABSTRACT

The use of high-volume horizontal hydraulic fracturing (fracking) has increased substantially over the past five years in the United States. Use of this drilling technology to extract natural gas from hitherto impermeable shale is expected to increase even more in coming decades. Two institutions, integration contracts and well spacing requirements, evolved to mitigate the common-pool economic wastes associated with conventional oil and gas drilling. U.S. regulators have applied these institutions to fracking. However, shale plays differ geologically from conventional plays and are subject to different extractive technologies. We theorize that the point-source pollution characteristics of conventional drilling allowed integration contracts and well space requirements to minimize local negative environmental externalities as an unintended byproduct of minimizing common-pool economic wastes. The non-point source pollution characteristics of fracking, however, make these institutions insufficient to minimize negative environmental externalities associated with drilling in shale plays, because the economic waste problem is different. If policymakers understand the crucial differences between conventional oil and gas plays and shale plays and the drilling technologies applied to them, they should be better equipped to craft fracking regulatory policies that internalize problematic externalities.

1. Introduction

The use of unconventional production techniques such as high-volume horizontal hydraulic fracturing (fracking) to extract oil and gas from previously difficult-to-access shale formations has rapidly increased over the past decade in the United States. This increase in unconventional production comes amidst controversy surrounding the perceived environmental impacts of new fracking techniques, as well as the perceived infringement by industry actors on the property rights of landowners unwilling to lease their mineral rights (Davis, 2012). Scholars of ecological economics and politics have jumped at the opportunity to study this nascent technology and have begun publishing works that examine the likely environmental (Clark et al., 2012; Davis and Robinson, 2012; Howarth et al., 2011; Osborn et al., 2011a; Rahm, 2011; Warner et al., 2013) and economic (Kelsey et al., 2012a-e; Kinnaman, 2011) consequences of this rapidly emerging industry.[1] Noticeably absent from much of this literature, however, is the development of institutional and political-economic theory. In this paper, we develop an institutional theory concerning oil and gas production in the United States to demonstrate that institutions designed to address the wastes associated with conventional drilling technologies are inadequate to address similar wastes associated with fracking technologies.

First, we examine the evolution of two institutions, integration contracts and well spacing requirements, which are frequently used in the United States to regulate oil and gas production. The geological conditions under which conventional drilling takes place and the extractive technologies used are such that resulting negative environmental externalities, such as the application of energy-intensive pumping technologies or local spillages, closely resemble point-source pollution problems in which economic wastes, such as inefficient production or unrecovered resources, are directly manifest as negative environmental impacts. Therefore, the reduction of economic wastes in conventional plays reduces negative externalities associated with local environmental impact. In conventional plays, integration contracts and well spacing requirements promote both economically efficient and relatively environmentally friendly resource extraction.

Second, we examine the use of integration contracts and well spacing requirements under the different geological conditions and extractive technologies associated with shale plays. We argue that potential negative environmental externalities associated with fracking, such as the contamination of underground aquifers, seismic activity, or physical damage to neighboring properties, closely resemble non-point source pollution problems in which

* Corresponding author at: Environmental Studies and Political Science, Binghamton University, P.O. Box 6000, Binghamton, NY, 13902-6000, United States. Tel.: +1 607 777 3337.
E-mail addresses: rholahan@binghamton.edu (R. Holahan), gbarnold@ucdavis.edu (G. Arnold).

[1] Other work has examined broader social and community implications of fracking (e.g., Anderson and Theodori, 2009; Theodori, 2009). However, we focus solely on the economic and local environmental consequences of fracking technology in this paper.

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the reduction of economic wastes does not necessarily result in a consequent decrease of local environmental impact. While the geology of most conventional oil and gas plays allows well operators to drill targeted, carefully controlled wellbores into known geologic formations, the geology of shale plays necessitates horizontal wellbores that expand into unknown geologic conditions (Chalmers et al., 2012). These differences imply that integration contracts and well spacing requirements are less effective at promoting economically efficient and environmentally friendly resource extraction in shale plays.

Our theory draws on the work of Libecap and Wiggins (1984, 1985), Wiggins and Libecap (1985) and Libecap (1989), who explore the use of voluntary and forced integration as mechanisms for minimizing common-pool economic wastes in conventional oil plays. We expand on their work by incorporating environmental impacts into production outcomes and then by holding institutions constant and theoretically exploring economic and environmental outcomes under differing geological and technological conditions. Policies designed to regulate fracking, we argue, should address the non-point source nature of the externalities produced by this technology; they should match the geological and economic realities of fracking (see also Scott et al., 2011).

Our argument is not about whether fracking is a normatively desirable production technology. Like all technologies, there are methods of use that are more or less economically efficient and more or less sustainable. Fracking may be pursued in a relatively economically and environmentally friendly manner, especially when its costs and benefits are compared to those associated with other common methods of producing energy from fossil fuels. Natural gas may indeed be a "transition fuel" that offers a bridge between carbon-based and renewable energy sources (Pacala and Socolow, 2004).[2] Our argument is that to achieve simultaneously the minimal amount of economic waste and environmental impact during resource production, regulatory institutions must address the economic incentives and environmental consequences jointly generated by the geology of shale plays and the technology used to exploit them.

The next section provides a brief review of recent policy scholarship concerning fracking and highlights the general lack of theoretical grounding in the literature. Section 3 introduces the common-pool economic waste problems in conventional and shale productions, respectively. Section 4 examines the institutional evolution of current oil and gas regulations by explaining how coordinating institutions evolved to address economic wastes associated with conventional drilling. It then discusses how the geological and technological differences between conventional drilling and fracking generate distinct economic incentives that, in turn, influence environmental impacts differently. Section 5 concludes with a summary and a discussion of potentially fruitful research avenues and fracking policy measures.

2. Existing Studies

While the policy literature on fracking is still in early stages of development, a substantial portion of it documents environmental concerns raised by scholars and the public, particularly with respect to water and air resources. A careful review of the literature shows that most articles fall into one of three categories. The first are review articles that note the sudden rise in fracking activity, discuss particular shale plays and regulations, or call for more research into the policy implications of fracking (e.g. Boersma and Johnson, 2012; Kinnaman, 2011; Rahm, 2011). The second are relatively atheoretical articles that focus on public opinion about or community responses to fracking (e.g. Brasier et al., 2011; Theodori, 2009). To the extent that these articles connect to theory, they tend to focus on scholarship about the social consequences of boom–bust cycles in fossil fuel extraction (e.g., Albrecht, 1978; Bates, 1978). The third group contains empirical articles that point to specific environmental impacts purportedly caused by fracking. Articles in this third group are often challenged on the grounds that the authors failed to account adequately for one or more important variables or processes (e.g., Cathless et al., 2012) or that the authors failed to link a particular impact to a particular fracking operation conclusively.

Osborn et al. (2011a), for example, evaluated 68 drinking water wells closer to or farther from active fracking operations, and found "systematic evidence for methane contamination of drinking water associated with shale gas extraction" (Osborn et al. 2011a, 8172). This conclusion was disputed by Saba and Orzechowski (2011), who questioned the representativeness of the data and argued that other factors could have been responsible for the observed methane concentrations; by Schon (2011), who pointed out that fracking fluid was not found in the well-water samples and questioned the geologic plausibility of the findings; and by Davies (2011), who called for a more rigorous research design and case selection procedure. Osborn et al. (2011b) subsequently defended their inferences and later published a more expansive study (Warner et al., 2013).

It is interesting to note that one of the primary criticisms of the work by Osborn et al. (2011a) was their inability to link systematically the negative environmental impacts they identified to specific fracking sources. In the realm of environmental economics and policy, however, difficulty establishing definitive cause-and-effect linkages occurs frequently in the analysis of non-point source pollution. It is likely that, as additional empirical studies are published concerning the environmental impacts of fracking, critics will continue to dispute the causality of these studies' findings. While our theorizing in this article is not intended to link impacts to sources conclusively, we believe it offers the first serious attempt at developing a theory about fracking based on the geological and institutional characteristics of shale plays. Developing a theory that recognizes the non-point source nature of the environmental impacts linked to this extraction technique may at least allow researchers to temper their expectations regarding the outcomes of such scholarship. This theoretical foundation also may lay the groundwork for more productive dialog about fracking impacts and their precursors.

While conventional oil and gas production also creates environmental impacts, much of the literature described above seems to be driven by an assumption, often unstated, that the environmental risks associated with fracking are new, different, and arguably greater than those previously linked to conventional drilling. Yet why this should be so is seldom discussed. The environmental risks of fracking appear so large and consequential, we argue, in part because institutions have evolved to manage (indirectly) the environmental impacts associated with conventional oil and gas production, but effective institutions for the same purpose do not yet exist for fracking or are only in the early stages of implementation.

In the following sections, we examine how institutions developed to manage conventional oil and gas drilling and how these institutions have been applied to unconventional fracking. We next discuss the common-pool economic waste problems of conventional oil and gas plays, then of shale plays. We focus on the interplay between geology and technology—specifically how the interplay in conventional plays produces one form of common-pool economic wastes and how the interplay in shale plays produces a different form.

3. Common-Pool Economic Waste Problems in Conventional and Shale Productions

3.1. Conventional Drilling: How It Occurs and the Common-Pool Problem

Oil and gas are common-pool resources, characterized by rivalry and non-excludability (Ostrom, 1990). Rivalry means that once a

[2] For a debate on the pros and cons of viewing shale gas as a transition fuel, see Howarth et al. (2011), Wang et al. (2011), Cathless et al. (2012), and Stephenson et al. (2012).