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Why does industry structure matter for unconventional oil and gas development? Examining revenue sharing outcomes in North Dakota

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ABSTRACT

Scholars have identified many determinants of regulatory outcomes in unconventional oil and gas development, but few have focused on industry structure. We examine the effects of company size and ownership on revenue sharing outcomes in North Dakota (ND), drawing on political economy bargaining models. We examine firm-level characteristics of ND's oil producers from 2005 to 2015, matching these data against revenue sharing outcomes and estimating effects using graphical and statistical methods. Along with this core analysis, we conduct key informant interviews with four elite actors in the unconventional oil and gas sector in ND, to provide supplementary details on industry structure and voluntary contributions to local communities. Our findings suggest that when industry is dominated by larger, publicly-traded firms, there is more revenue sharing between firms and the state government. However, we find anecdotal evidence that smaller, local firms may better target resources towards local needs. Our work contributes to a better understanding of the varied outcomes at the sub-national and sub-state level and expands the "resource curse" literature that suggests that industry characteristics shape local outcomes.

1. Introduction

Since 2000, U.S. oil production from hydraulically fractured[1] wells has grown by more than 4000%, from approximately 102,000 barrels per day to more than 4.3 million in 2015 [2]. It now accounts for more than half of total U.S. oil production [2]. The massive expansion of hydraulic fracturing (hereafter, HF)[2] has taken place across the U.S., from the southern Eagle Ford Formation, east to the Marcellus, and north to the Bakken Formation. The growth in HF has had both positive and negative impacts at national and local levels.

At the national level, unconventional oil and gas production from HF has led to improvements in U.S. energy independence, with crude oil imports falling from 456 million barrels per month in 2006 to 307 million barrels in 2016 [3]. Natural gas production from HF has driven down natural gas prices, which has led many utilities to choose gas over coal for power generation and has consequently reduced the power sector's carbon intensity [4]. The HF industry also has had impacts in areas where unconventional oil and gas is produced, transported, processed, and consumed. Local benefits are largely economic, in the form of increased local government revenue and an increase in local economic activity [5–7]. Yet, there are also local costs associated with HF, including the economic cost of increased pressure on local services and infrastructure and the environmental costs associated with wastewater disposal and air pollutants [8,9].

The impacts of HF activity are mediated by the institutions that surround unconventional oil resources [85]. Environmental regulations and taxation regimes, for example, can both promote industry growth and bring economic benefits to state and local governments. These regulations, along with environmental provisions, can also affect the distribution of wealth, long-term fiscal stability, and negative externalities of oil extraction. In the U.S., HF activity is primarily regulated by states [9]. Past research has assessed variation in regulation

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[1] Following [81], we adopt a broad definition of hydraulic fracturing that includes, but is not limited to, "the specific phase of high-pressure extraction (hydraulic fracturing, which can be done in vertical wells); fracturing efforts combined with horizontal drilling (horizontal hydraulic fracturing); and the more recent innovations of combining fracturing, drilling, and specific water and chemical mixtures (high-volume, slickwater, horizontal hydraulic fracturing)." Also see Ref. [1].

[2] Abbreviations used throughout this paper include: Hydraulic fracturing – HF, Corporate social responsibility – CSR, Community benefits agreement – CBA, North Dakota – ND, Obsolescing bargaining model – OBM, Multinational enterprise – MNE, Political bargaining model – PBM, and Herfindahl-Hirschman Index – HHI.

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across states [10], but little has been done to understand how different regulatory regimes influence local effects of the HF industry [9]. We take a first step towards filling this gap, by investigating the relationship between industry characteristics and revenue sharing outcomes, both in terms of formal taxation regimes and informal, often philanthropic, economic redistribution.

Striking the regulatory balance between supporting industry and protecting communities usually entails bargaining between companies and governments over the terms of financial payments, environmental regulations, and other conditions for exploration and production. In the U.S., this bargaining is complicated because most regulation occurs at sub-national levels. Firms must bargain separately with each state, and even each county or community, in which they are active. Private and co-regulation occur at the local level, where community perceptions and industry characteristics interact to shape revenue sharing outcomes.

In this paper, we thus seek to contribute to understanding the complex causal chain between oil and gas production and the associated socio-economic and environmental impacts. Specifically, we explore the relationship between the structure of the HF industry and state and local regulatory outcomes. We focus on revenue sharing outcomes and help illuminate an understudied aspect of how regulation is developed and governed [12]. Our work aligns with other scholarship on taxation structures at the sub-national level, including literature on the resource curse [13] and on the social impacts of unconventional oil and gas production [14]. In this study, we posit that the amount of revenue sharing and form of the regulatory relationship between industry, states, and local communities is related to the structure of the HF industry, which, we argue in Section 3, differs in fundamental ways from conventional oil and gas production.[3] We do not specify an optimal level of revenue sharing, but instead explore factors, specifically industry characteristics, that influence revenue sharing.

To shed light on the bargaining that occurs between industry and both governmental and non-governmental actors, we compile a novel data set of ND's HF industry. We focus primarily on severance taxes collected at the state level. The remainder of this paper proceeds as follows: in Section 2, we briefly lay out some of the socio-economic and environmental impacts of HF, especially at the local level. Section 3 highlights the differences between conventional and unconventional oil and gas production, with the latter including horizontal drilling and HF. In Section 4 we draw on political economy literature on regulator-firm and community-firm bargaining to develop hypotheses concerning the effects of industry characteristics on revenue sharing outcomes. In Section 5 we use our compiled data set of well-operators to characterize the HF industry in ND between 2005 and 2015 and test our hypotheses. In ND, the oil and gas industry has grown rapidly in the past decade and revenues from oil and gas made up more than half of the state's revenue in 2013 [15]. We assess the relationship between industry characteristics and state revenues from oil and gas using graphical and regression methods, controlling for the effect of confounding trends in total production and oil prices. In addition, we comment on philanthropic contributions from industry, relying on select key informant interviews with stakeholders from public, private and non-governmental organizations involved in ND's oil and gas industry.

We find that growth in the average market share of publicly-owned firms is associated with a growth in state revenue from oil and gas taxes. We find the opposite relationship with respect to privately-owned firms and state revenue. Beyond publicly collected revenues, our discussions with local stakeholders suggest that firm size may not be a major factor determining philanthropic contributions, although we gather some anecdotal evidence that small, local firms may be more responsive to community needs. We discuss possible mechanisms through which industry characteristics lead to increases or decreases in the share of firm revenues allocated to state government and local communities. The work presented here is a first step in illuminating the dynamic forces that shape HF policy and regulation in the U.S. [16], and, in Section 6, we conclude by highlighting implications of this research and offering suggestions for future research.

2. Impacts of hydraulic fracturing

Increased oil and gas activity can have positive and negative effects at both the state and local levels. Changes in a region's economic activity can have direct and indirect effects on communities. In 2014, the oil and gas sector directly contributed 294 billion USD to the U.S. economy. Indirectly, increased employment in the oil and gas industry has effects on other sectors of the economy, such as food services, entertainment, and financial services. A recent study estimates that each additional drill rig in the U.S. creates 31 jobs in the short term and 315 over the long term [6]. Assuming growth in labor supply does not outpace demand, increased labor demand can lead to a growth in wages and reduced unemployment [7], at least in the short term. However, there are also significant costs associated with oil and gas extraction. Increased economic activity puts significant pressure on public systems. Roads are stressed due to population growth and transport of heavy goods and machinery. Communities often face rapid growth in demand for public services, like education, healthcare, and emergency services.

HF also has multi-scalar environmental impacts. From a climate perspective, the displacement of coal by natural gas has the potential to reduce carbon emissions. Conversely, this reduction could be offset by fugitive methane emissions from natural gas production and transport or from increased energy consumption that results from lower energy prices [8,9]. In areas such as ND, where the infrastructure needed to capture, transport and process associated natural gas is not well developed, the gas is flared. Hydraulically fractured and horizontally drilled wells have been found to negatively affect human health and home values because of air and noise pollution [4,17,18]. HF is also water intensive, which can cause problems in water-scarce production areas like Texas [19]. Additionally, much of the water that is used in production returns to the surface as wastewater. Wastewater can contain harmful compounds like heavy metals and naturally occurring radioactive materials [20], which, when leaked or spilled, cause significant land and water pollution. These risks are especially high in areas without previous experience with oil and gas activity, as the infrastructure needed to safely transport and dispose of wastewater may not be in place [21,22].

In the short- and medium-term, formal and informal regulatory regimes can help to offset the costs of oil and gas development. Taxation brings in billions of dollars of revenue in the form of severance taxes and impact fees at the state level and property taxes at the local level [9]. Revenue can also flow to governments or other community-based organizations through voluntary contributions from industry. Some examples of voluntary contributions are 1) corporate social responsibility (CSR), 2) corporate philanthropy, and 3) community benefits agreements (CBAs), where industry provides funds or agrees to abide by certain development rules in order to secure cooperation or support [23]. A 2016 study, which focuses on short and medium-term timelines, finds that oil and gas development often has net positive effects on local government finances [24]. However, in the long term, increased production can lead to lower energy prices. This boom and bust cycle can have large negative economic consequences, leading to drops in revenue and out-migration. If municipalities had expanded public services to meet the demand from a growing sector, these changes in the economy and the labor force can leave such services under-utilized [8]. Few studies have empirically examined the long-term wealth-effects of shale development. Even if the effects are positive both in the short and long term, the distribution of income or wealth within a community can be uneven, leading to increased socio-economic inequality [8].

Environmental risks can be mitigated by regulations that have been

[3] For an overview of social science research on unconventional energy, see Ref. [81].