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Brooklynn J. Anderson
Mississippi State University Extension Service

Gene L. Theodori
Sam Houston State University

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LOCAL LEADERS' PERCEPTIONS OF ENERGY DEVELOPMENT IN THE BARNETT SHALE

BROOKLYNN J. ANDERSON*

MISSISSIPPI STATE UNIVERSITY EXTENSION SERVICE

and

GENE L. THEODORI

SAM HOUSTON STATE UNIVERSITY

ABSTRACT

In recent decades, the production of natural gas from unconventional reservoirs (i.e., tight gas sands, coalbed methane resources, and gas shales) has become commonplace within the U.S. energy industry. The Newark East Fort Worth Basin field–called in the vernacular, the Barnett Shale–in north-central Texas is one of the largest unconventional natural gas fields (by production volume) in the United States. Unlike many conventional energy development projects, which typically occurred in small rural areas, much of the Barnett Shale production is occurring in and around a highly urbanized geographical setting. In spite of recent efforts to assess the economic effects of Barnett Shale production, little attention has been directed toward understanding the social impacts associated with this immense unconventional energy development. In this article we use key informant interview data collected in two Barnett Shale counties to investigate the reported positive and negative outcomes of unconventional energy development, as well as the similarities and differences in perceptions between respondents from each of the study counties. We then discuss practical applications and future research implications of our findings.

The production of natural gas from unconventional reservoirs (i.e., tight gas sands, coalbed methane resources, and gas shales) has become commonplace within the U.S. energy industry in recent decades. Of the 17.2 trillion cubic feet (tcf) of natural gas produced in the U.S. in 1990, roughly 16 percent (2.8 tcf) was from unconventional sources (Kuuskraa and Stevens 1995). By 2006, the percentage of unconventional gas production to total domestic production increased to 43 percent (8.5 tcf of the total 18.6 tcf produced) (EIA 2008). Recent projections by the Energy Information Administration (EIA 2008), the statistical agency of the U.S. Department of Energy, suggest that onshore production of unconventional natural gas will increase to 9.6 tcf in 2018 and hold at or near that level for the next dozen years. In essence, unconventional natural gas will constitute roughly one-half of the projected 19.6 tcf onshore production by the year 2030 (EIA 2008).

*Direct communications to Brooklynn Anderson, Department of Agricultural Economics, P.O. Box 5187, Mississippi State, MS 39762, Phone: (979) 220-9973, E-mail: banderson@agecon.msstate.edu

Data reveal that in 2005, nine of the twelve largest U.S. natural gas fields (in terms of production) produced gas from unconventional resources (Kuuskraa, Godec, and Reeves 2007). The San Juan Basin Gas Area in northwestern New Mexico and southwestern Colorado topped the list. Natural gas production from coalbed methane and tight gas sands in the San Juan Basin resulted in 3.8 billion cubic feet per day (bcfd) in 2005. The Newark East (Barnett Shale) Forth Worth Basin field in north central Texas, with an average production of 1.4 bcfd, was second on the list that year.

The Newark East field, called hereafter the Barnett Shale, is currently the most productive gas field in the State of Texas. Recent estimates place production in the Barnett Shale at 3.7 bcfd (The Perryman Group 2008). As of 2007, natural gas production in the Barnett Shale accounted for 4.3 percent of the total production in the United States (The Perryman Group 2008). From a rural, natural resources sociological perspective, what is most conspicuous about the Barnett Shale is that the core production area is *not* in a rural area, as often happens with onshore energy developments. Instead, this massive, large-scale energy boom is occurring in and around a highly urbanized geographical setting: the Fort Worth and Arlington metropolitan areas.

For years, geologists and engineers have chronicled the development of the Barnett Shale and assessed the amounts of known, undeveloped, and technically recoverable natural gas in the reserve (Ambrose, Potter, and Briceno 2008; Bowker 2003, 2007; Kuuskraa et al. 1998; Montgomery et al. 2005; Pollastro 2007). Recent attention has turned to assessing the aggregate economic impact of the Barnett Shale (The Perryman Group 2007, 2008). In 2008, the economic impact of the Barnett Shale activity on the local economy was estimated at $8.2 billion, up from $5.2 billion in 2007. Little attention, however, has been directed toward understanding the social impacts associated with this immense unconventional energy development at the local level. Indeed, the authors are unaware of any published sociological studies on the topic.

In this paper we analyze responses from key informants in two Barnett Shale counties to better understand their perspectives regarding the local-level impacts of this unconventional energy development. Specifically, we examine the responses reported by key informants to three interview questions. Respondents were asked: (1) what local-level benefits have occurred because of increased energy development; (2) what perceived negative impacts have accompanied increased development; and, (3) whether the benefits of development have outweighed the costs. Answers to these questions shed light on some local-level consequences of

unconventional energy development that might be considered in future research. Before describing the data and findings, we briefly summarize previous literature on conventional energy development and explain why unconventional energy development is on the rise.

BACKGROUND

Conventional Energy Development

Social impacts of onshore energy production have been studied in the past, generally within the contexts of rural western energy "boomtowns." In these cases, the positive and negative consequences of development, as well as the magnitudes of their effects, were said to be influenced by contextual factors such as community size and rate of population growth.

Much of the onshore energy development of the past several decades has occurred in remote locations and has resulted in rapid population growth (10–15% per year) triggering various forms of social disruption (Albrecht 1978; Freudenburg 1982; Gilmore 1976; Lillydahl et al. 1982; Little 1977). In spite of some criticism (Wilkinson et al. 1982), the consensus among researchers is that the negative consequences of boomtown growth have traditionally outweighed the advantages. The negative impacts encountered have been grouped into three general categories (Albrecht 1978), including social problems, service delivery problems, and environmental problems.

Feelings of alienation and isolation (Gilmore 1976; Lillydahl et al. 1982; Little 1977), integration problems among newcomers (Albrecht 1978), decreased density of acquaintanceship (Freudenburg and Gramling 1992; Lovejoy 1977), and decreased effectiveness of socialization and deviance control (Freudenburg and Gramling 1992) reported in past research were, in part, a function of rapid rural development. Other social problems, such as shifts in friendship selection, social class alignments, and community power structure have also been shown to result from rapid growth, along with added strains on communication patterns and a reported loss of sense of community (Bates 1978).

In western energy boomtowns, community planning often failed to keep pace with the influx of new residents, a disparity shown to place burdens on housing supplies, facilities, and services (Albrecht 1978; Gramling and Brabant 1986; Gramling and Freudenburg 1990; Little 1977), as well as on existing medical, educational, and recreational facilities (Cortese and Jones 1977; Gramling and Freudenburg 1990; Little 1977). Any new taxes generated from development were typically subject to a five to ten-year lag between the need for infrastructural

enhancements and the tax base increase needed to fund them. Even after this delay passed, additional revenue often failed to cover costs for increased social service needs (Albrecht 1978; Freudenburg 1982, 1984; Gramling and Brabant 1986; Little 1977).

Impacts on the physical environment of rural boomtowns included aesthetic disturbances, loss of access to the outdoors, and limitations to alternative land uses (Albrecht 1978; Leistritz and Voelker 1975; Little 1977). Wildlife habitat resources, typically more abundant in rural than in urban areas, were also highly susceptible to negative impacts of growth and development (Freudenburg and Gramling 1992).

Unconventional Energy Development

Metropolitan areas in the Barnett Shale where unconventional natural gas development is rapidly occurring offer another context in which to examine the positive and negative impacts of energy development. Unconventional energy exploration and production has greatly increased over the last several decades because of several factors (Durham 2006; Forbis 2001; Martineau 2003). First, the onset of horizontal, multidirectional drilling techniques has allowed greater access to natural gas deposits, increased well productivity, and reduced surface intrusion. The advent of hydraulic fracturing technology has also spurred the increase in unconventional energy development by allowing economical access to resources that were once very difficult and expensive to extract. Wells are fractured by flushing large quantities of freshwater into them at extremely high pressure levels to create cracks, called fractures, in the shale. This process overcomes difficulties associated with the limited porosity of the shale by loosening natural gas and allowing it to flow more freely through the rock formation for easier extraction. Technological advancements continue to make the fracturing process more cost-effective. Meanwhile, rising natural gas prices contribute to the increased profitability of unconventional energy development. It should be noted that natural gas reserves reached through unconventional methods would be inaccessible via traditional extraction methods due to the characteristics of the geological formations in which they are located. Access to resources in urban areas, however, is especially enhanced by technological advancements that effectively reduce the surface footprint associated with resource extraction.

Because natural resource deposits have been most plentiful in the shale beneath the more metropolitan of Barnett Shale counties, these areas have experienced substantial unconventional energy development. In spite of this, industry activity has not led to the rapid population growth witnessed in the western energy

boomtowns of the past. Nor can this development be expected, *a priori*, to closely parallel offshore oil development, which has occurred near—but not in—larger metropolitan areas. As a result, both the positive and negative economic and social impacts of unconventional energy development can be expected to differ in nature and magnitude from those reported in past research.

In contrast to the extant literature addressing the social, economic, and environmental impacts of conventional energy development, little empirical research has been directed at uncovering the potential benefits and/or negative consequences associated with unconventional energy development. We contend that an exploration of the various impacts faced by communities experiencing unconventional energy development is timely and particularly salient. In this article we use key informant interview data collected in two Barnett Shale counties to investigate the reported positive and negative outcomes of unconventional energy development. Moreover, we assess the differences and similarities in perceptions between respondents from each of the two study counties. Policy and resource use decisions associated with this development have important implications for local populations.

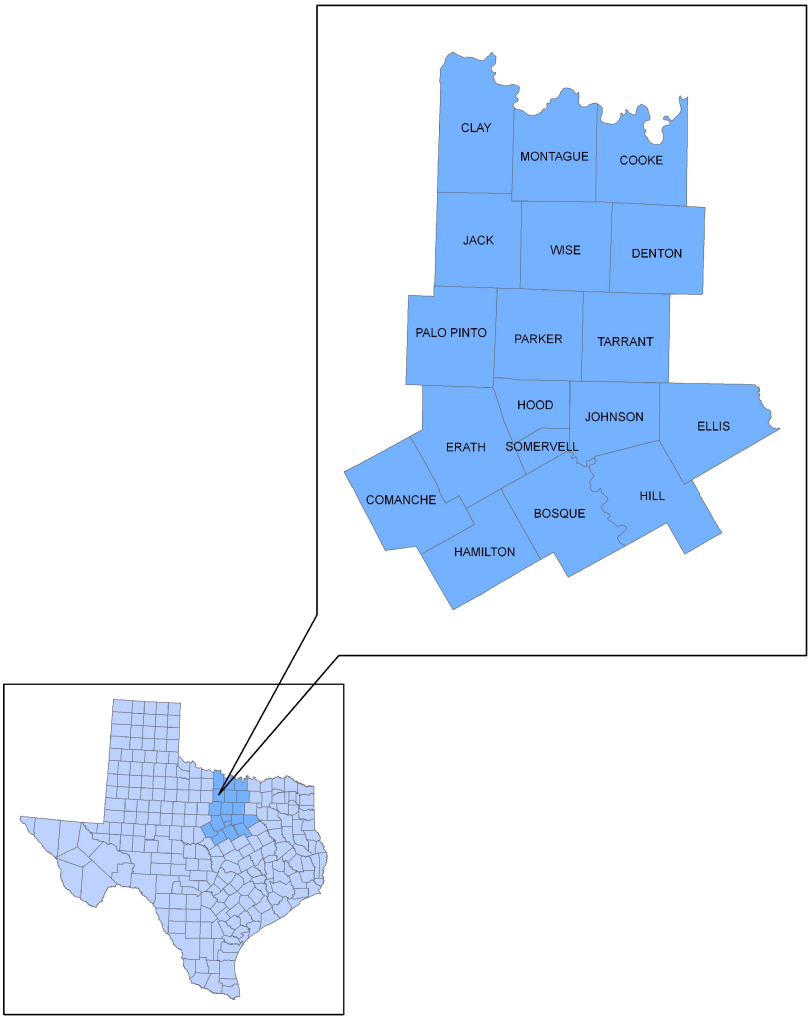
METHODS

Study Area

While conventional oil and gas production throughout the State of Texas has declined during recent years, unconventional energy development in the Barnett Shale region is becoming increasingly more common (Givens, Zhao, and Steward 2004). The geographic boundaries of the Barnett Shale region are not clearly defined. Known limits of the reservoir are constantly expanding as operators continuously explore areas considered on the fringe. For purposes of this paper, the Barnett Shale refers to an 18-county region encompassing Bosque, Clay, Comanche, Cooke, Denton, Ellis, Erath, Hamilton, Hill, Hood, Jack, Johnson, Montague, Palo Pinto, Parker, Somervell, Tarrant, and Wise Counties (see Figure 1).

The first commercially successful well in the Barnett Shale was drilled in 1981 near Newark, TX (Forbis 2001), representing the start of a boom that spread throughout Wise and Denton counties in the late 1990s (Durham 2006; Piller 2006). The drilling boom has now extended into surrounding counties and is expected to spread even further. As such, the Barnett Shale constitutes the largest natural gas reservoir, or "play" as referred to in the vernacular, in Texas.

FIGURE 1. THE BARNETT SHALE REGION OF TEXAS.



The Barnett Shale is a geologic formation that is located at a depth of 6,500 to 8,500 feet and runs horizontally. The rock formation is 1,000 feet thick in some places and as shallow as 30 to 50 feet thick in others (Hayden and Pursell 2005). The Ellenberger Zone, a water bearing formation that lies directly below the Barnett Shale, must be avoided during drilling to maintain profitable mineral extraction (Sanders n.d.). These characteristics have historically made it difficult to

develop the resources in the Barnett Shale economically. The recent advancements in the field of unconventional extraction techniques have made Barnett Shale production much more technologically and economically feasible. The success witnessed in this area begs the question, "In what ways, and to what degree, has energy development positively and negatively impacted communities in the Barnett Shale?"

For answers to this question, we turned to two Barnett Shale counties: Wise County and Johnson County. Two main reasons prompted the selection of these two particular counties. First, they provide a longitudinal perspective to a certain degree. Wise County, the county where much of the initial development was performed after the first well completion in 1981, was selected to represent a site with relatively mature energy development. Conversely, Johnson County, the county called an emerging "sweet spot" (Hayden and Pursell 2005) when this research was conceptualized, was chosen to represent a site where large-scale exploration and production activities were just beginning. The second influential factor in the selection of these two counties was the willingness of local key informants to participate in this study. Participants in both Johnson County and Wise County were supportive of this research and enthusiastic about sharing their experiences.

While Wise County is somewhat more metropolitan than Johnson County, both displayed the types of population trends we would expect to occur with unconventional energy development (USBC 2006). According to U.S. Census Bureau figures, between the years 2000 and 2005, population in Wise County grew by 16.2%, with the largest annual increase occurring between 2000 and 2001 (5.2%). In Johnson County, population grew by 15.4% during the same period, with the largest annual increase also taking place between 2000 and 2001 (4.2%). Neither of these rates approaches the threshold for boomtown growth, which is 10-15% per year (Little 1977).

Data Collection

In March 2006, key informant interviews were conducted in Wise County and Johnson County. The utilization of key informants has long been central to the basic methodological techniques used by anthropologists (Campbell 1955; Poggie 1972; Tremblay 1957; Young and Young 1961). As a methodologically acceptable and highly practical means of gaining information, the key informant technique has become relatively common in organization analyses (Seidler 1974) and community sociology (Claude, Bridger, and Luloff 2000; Krannich and Humphrey 1986;

Schwartz, Bridger, and Hyman 2001). Key informants provide important knowledge about community characteristics that cannot be measured precisely with secondary data (Claude et al. 2000; Fetterman 1989; Krannich and Humphrey 1986; Schwartz et al. 2001).

Interviews with key informants were conducted either individually or in groups, depending upon logistical constraints and participants' preferences. Key informants in both counties responded to a series of semi-structured interview questions. Interviewed informants included municipal and county leaders as well as concerned and active local citizens. Participants represented convenience samples from each county and were selected based on position and availability, in coordination with a local contact from each site. Below is a table depicting the participants and their positions (see Table 1).

TABLE 1. STUDY PARTICIPANTS.

	NUMBER OF PEOPLE INTERVIEWED	
POSITION	JOHNSON COUNTY	WISE COUNTY
County government official.	3	2
Law enforcement official.	1	0
Criminal judge.	1	0
Congressional representative.	1	0
State representative.	1	0
Newspaper editor/reporter.	1	1
City mayor.	1	0
City manager.	1	0
Director of economic development* .	2	0
Chamber of commerce.	1	0
Business owner/operator.	2	0
Hospital administrator.	1	0
Concerned citizen.	2	3

*One director for each of two Johnson County municipalities was interviewed.

FINDINGS

The findings from the two counties revealed many similarities as well as some substantial differences. While study participants perceived many similar positive and negative consequences, they weighed the effects of those consequences differently. This apparent difference in weighting led to a different overall response pattern for the question regarding benefits versus costs of development.

Respondents in both Wise and Johnson Counties agreed that energy development had stimulated economic prosperity for their communities. The benefits identified included increases in city revenue, property values, and household income. Local leaders also noted the industry's positive impact on the job market and local unemployment rates. According to informants, the retail sector has also benefitted from development through the improvement of shopping choices and the presence of new businesses. Respondents in Johnson County differed from those in Wise County inasmuch as they listed improvements in schools and medical facilities among the benefits of energy development, whereas Wise County respondents reported only economic benefits. Overall, however, the responses to this question indicated that leaders in both counties recognize the economic contribution of the energy industry at the local level. This impression has been corroborated by economic impact assessments, including one conducted by the Perryman Group, which attributed $10.8 billion in annual economic output and 108,000 jobs to the development of Barnett Shale resources (King 2007).

Several common themes surfaced among respondents regarding the negative consequences of energy development. These can be generally classified into three categories: potential threats to public health and safety, environmental concerns, and quality of life issues. First, respondents in both counties mentioned several health and safety-related concerns during the interview process. A crucial concern focused on the increased truck traffic on county roads as a byproduct of increased energy development. This increase in traffic is largely due to the water transportation needs involved with the well-fracturing process. Freshwater must first be transported to the well site in large quantities, then the saline water that emerges from the fractured well must be transported to a disposal site. Respondents asserted that the sheer number of large vehicles poses a threat to other drivers. Additionally, informants claimed that many truck drivers fail to adhere to legal mandates and customary safety precautions, leading to an increase in traffic accidents and fatalities.

Beyond traffic-related safety concerns, natural gas drilling itself can pose a danger to nearby residents. Gas leaks and explosions, though not frequent, may

occasionally occur, forcing the evacuation of surrounding citizens. Such incidences, although extremely rare, can possibly cause severe injury and/or death. The dangers involved with natural resource extraction are not unique to unconventional gas development, though new technologies do allow for drilling within a much closer proximity to residential areas. This places many citizens in a position to potentially be adversely affected by drilling and/or production accidents.

Respondents, specifically those from Wise County, also indicated health and safety concerns involved with injection well placement. As Wise County moves from the initial exploration and drilling phase into the production and maintenance phase, operations have resulted in an increased need for brine disposal. According to the informants, local citizens oppose the placement of disposal wells in their immediate vicinity because improper well design may allow for potential contamination of groundwater supplies. Several respondents even expressed concerns that the proximity of these wells to the local population has been the cause of certain cancer cases. While available data neither substantiate nor contradict this assertion, some local residents believe that experts have intentionally avoided researching these cases, fearing the implications of potential findings.

Besides issues related to public health and safety, environmental concerns also surfaced during discussions with key informants. Several informants mentioned a general decline in environmental quality, and one respondent specifically expressed concern about air pollution. The greatest environmental concern by far mentioned in both Wise and Johnson Counties dealt with freshwater supplies. The fracturing process requires enormous amounts of water–as much as five to eight million gallons per fracturing procedure.[1] Sources differ in their reporting of the number of fracturing procedures required per well. Wilson (2007a), for example, reported that each well is fractured three times during the first year of production, then once every six months thereafter. She later reported that wells are fractured an average of 17 times each (Wilson 2007b). This amounts to a substantially large quantity of water use.

While informants in both counties listed water as a major energy-related concern, the availability of freshwater was of greater concern in Wise than in Johnson County. This may be attributed to a combination of factors. First, energy production occurring in Wise County exceeds that of Johnson County, meaning that the amount of freshwater used in extraction procedures is also greater in Wise County. Divergent reports make direct water use calculations difficult, but a higher

[1] This information was obtained via personal communication with David Burnett, Director of the Global Petroleum Research Institute at Texas A&M University.

well count clearly requires greater amounts of water. As early as February 2000, Wise County reported 2,436 regular producing gas wells compared with only two producing wells in Johnson County. Well counts have since increased in both counties, numbering 3,489 in Wise County as of February 2006 and 195 in Johnson County (Texas Railroad Commission 2006).

In Johnson County, differences with respect to freshwater concerns emerged between municipal leaders and county officials. Municipal leaders have arranged for water provisions from multiple surface water sources, including Aquilla Lake, Lake Pat Cleburne, and Lake Whitney. Consequently, these leaders felt confident about their ability to meet community water needs. County-level officials, on the other hand, expressed a deeper concern about the availability of freshwater, particularly considering the reliance of unincorporated places on groundwater. These leaders noted multiple instances among constituents where private wells had run dry, indicating that concern may be greater for individuals relying on groundwater as opposed to surface water for their ongoing needs.

Besides health and safety concerns and environmental issues, respondents mentioned several adverse impacts on quality of life resulting from increased energy development, including inconveniences related to both the drilling and production phases. The drilling process typically lasts approximately 65 days (Giraud 2006) and necessarily includes round-the-clock noise and lighting, which can disturb nearby residents. Changes to the aesthetic value of the landscape was also mentioned as a potential quality of life impact.

The primary quality of life concern mentioned by informants in both counties pertained to the condition of the local roads, especially county roads. Truck traffic traveling these roads has caused a disruption in the way of life for local people. County roads and, to a lesser degree, municipal thoroughfares are being damaged more quickly than they can be repaired. Revenue from natural gas production helps to abate this situation within city limits, but county officials must rely on money allocated from the State. Many officials see this as only a temporary inconvenience that will disappear once the Barnett Shale's resources have been depleted, but this problem nonetheless poses a threat to the present quality of life in affected counties.

Informants in both counties stressed the influence of mineral rights ownership as a potential factor in perceived quality of life. They readily acknowledged that many citizens were becoming very wealthy very quickly. A sizeable financial gain from the energy industry presumably often outweighs any short-term inconveniences caused by industry operations for those upon whom such benefits are bestowed. Many social costs associated with development, however, are borne

by members of the community who do not benefit directly from the industry's presence. Quality of life disturbances do not accrue only to those for whom increased development has proven lucrative (i.e., mineral rights owners). Thus, while many do benefit from development and believe that the associated costs are warranted, public opposition may arise from those who will not personally benefit from energy industry activity. Furthermore, as shifts occur in the distribution of wealth, changes in the local power structure may result, as those who have benefitted financially begin to seek positions of leadership. In such cases, informants claimed, ensuring that decisions made by those in power continue to reflect the needs of the community as a whole rather than those of the wealthy elite is important.

After itemizing the positive and negative consequences of energy development, informants in Johnson and Wise Counties were asked to give their overall impressions. Specifically, respondents were asked whether the benefits of energy development outweighed the costs. In Johnson County, the county where the massive, large-scale development was just beginning to occur, respondents unanimously agreed that the benefits of production would outweigh the costs. In contrast, Wise County respondents unanimously reported that the costs outweighed the benefits. These responses may reflect differences in site maturity between Johnson County, where the massive development has only recently begun, and Wise County, where citizens have been exposed to intense development efforts for over a decade. While respondents from both counties acknowledged the benefits of energy development, the enthusiasm of the Wise County respondents may be overshadowed by the daily presence of, and exposure to, the associated costs in relation to health and safety, resource use, and quality of life. It also appeared that respondents in Wise County are well aware that their local resources are finite, as expressed by one concerned citizen: "We need energy, but we need water, too. If you had to choose, would you rather be cold or thirsty?"

CONCLUSIONS AND LIMITATIONS

Overall, our findings demonstrate that localities experiencing unconventional energy development *do* face negative consequences in addition to positive impacts. In spite of economic benefits of unconventional energy development that were readily acknowledged by local leaders and concerned citizens in Wise and Johnson Counties, these individuals also expressed apprehension over perceived adverse consequences. Potential threats to public health and safety, such as increased truck traffic, unsafe driving practices, gas leaks, and explosions, were among the concerns

mentioned. Environmental concerns were expressed mostly in terms of water resources, as their use is closely tied to unconventional energy development. Temporary disturbances caused by noise, lighting, traffic, and conflicts over mineral rights comprised the quality of life issues addressed by participants. Concerns regarding negative consequences were greater among respondents in Wise County, the site where energy development was more mature.

To more fully understand the association between unconventional energy development and social consequences, additional research on both the positive and negative energy-related impacts experienced in the Barnett Shale, as well as in other areas that are beginning to employ unconventional techniques for oil and gas extraction (e.g., Bakken Shale, Fayetteville Shale, Haynesville Shale, Marcellus Shale) is warranted. Future research should address the types of impacts and concerns outlined here, including increased truck traffic and accidents, freshwater resource depletion, wastewater disposal, etc. Continued reliance upon the indicators used to measure social disruption in the western energy boomtowns of the past would likely yield misleading results for unconventional energy development, particularly in a metropolitan context like that of the Barnett Shale. Rather, public health and safety concerns, environmental impacts, and quality of life levels should all be given greater attention.

Future research should also empirically examine the differences in perceptions among diverse stakeholder groups. Municipal leaders and county-level officials, for example, face different challenges and, therefore, may perceive energy-related issues differently. While the present study included both types of officials, the interviews and participant selection processes did not allow for in-depth analyses of their responses. Furthermore, an understanding of the similarities and/or differences between local leaders' perceptions and those of the general citizenry may offer valuable insights. Lastly, examinations of the interpersonal dynamics within energy-producing communities and investigations into the ways in which increased energy development affects wealth and power at the local level are warranted. In closing, this study has introduced indicators of social disruption designed to better reflect the experience and concerns of local leaders and the public in areas facing increased unconventional development of natural gas resources and has demonstrated the need for further research into the local-level impacts of unconventional energy development.

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