The Effect of Proximity to Energy Development on Public Attitudes: Fracking in the U.S.

by

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Abstract

An oil and gas extraction technique commonly referred to as "fracking", "hydraulic fracturing", "hydrofracking" or "unconventional shale development" has recently emerged as a major national and international policy issue. This combination of new and preexisting technologies has quickly spread around the world, allowing for the development of large, previously unviable oil and gas reserves. A large body of literature on "NIMBY" and "LULU" phenomena suggest that proximity to similar types of energy development can shape public attitudes toward new energy facilities and development. However, previous research has failed to account for how previous industry activity interacts with current industry efforts in shaping attitudes. By combining geospatial data on historical oil and gas industry activity and current shale development with a nationally representative survey of U.S. residents (N=1,061), we examine how proximity to previous *and* current oil and gas development independently influence attitudes toward fracking. While we find limited evidence for the impact of historical oil and gas development on current attitudes toward fracking, survey respondents within a current shale play were more likely to support fracking. Based on these findings, we discuss recommendations for future research and energy policy.

Keywords: fracking; hydraulic fracturing; GIS; natural gas; shale gas; public perceptions

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Table of Contents

1. Introduction

Over the past several years, the use of an unconventional oil and natural gas extraction technique commonly referred to as "fracking" has emerged as a critical and contentious policy issue across the U.S, especially in communities slated for this type of energy development. In the past, efforts to evaluate attitudes and action in contentious energy debates have relied on the concepts of Locally Unwanted Land Uses (LULUs) or Not In My Back Yard (NIMBY) attitudes: that local residents oppose proximal energy development on self-interested grounds (Schively, 2007). Previous studies have also shown that experiences with similar industries can play a crucial role in shaping how residents think about and behave toward current industry activity, though in varied ways (Brasier et al., 2011; Freudenburg & Gramling, 1994; McAdam & Boudet, 2012).

Building on the work of Boudet et al., (2014), we combine a nationally representative survey of U.S. residents (N=1,061) with geospatial data on current and historical patterns of oil and gas development in the U.S. to examine how proximity to oil and gas development in both the past and present influences attitudes toward fracking. We focus on the effect that these spatial factors have in comparison to widely studied micro-level and demographic factors, such as worldviews or political ideology. The use of a nationally representative survey to evaluate the impact of experience with development on attitudes is unique. Most previous studies of the relationship between experience and attitude rely on case studies of individual siting disputes (see Schively, 2007).

2. Background

2.1. Understanding fracking: process and projections

The term "fracking" refers to an oil and gas drilling technique that involves the injection of a mixture of water, sand and lubricating chemicals, known as "fracking fluids" into an oil or gas well under high pressure. Doing so expands the fractures underneath the earth allowing for the flow of oil and gas to the surface, where it is collected (Pye, 1973). The process is not new: it was first used by Halliburton to extract natural gas in 1949. However, in the late 1990s and early 2000s, it was combined with new drilling technologies that allowed wells to be drilled horizontally—or what is sometimes referred to as "horizontal directional drilling"—and improved well stimulation fluids (Armstrong et al., 1995). This resultant combination allowed oil and gas companies to begin extracting oil and gas from formations of tight shale rock—formations which were previously unviable due to the high cost of extraction.

This expansion of fracking has had a significant impact on the nation's oil and gas production. The Energy Information Administration (EIA) notes that shale gas production could produce 440-540 trillion cubic feet of natural gas between 2012 and 2040, with shale gas production accounting for as much as 53% of all U.S. natural gas (U.S. Energy Information Administration, 2014). The use of fracking will likely allow the U.S. to become a net exporter of natural gas in the near future (Davis & Hoffer, 2012; U.S. Energy Information Administration, 2014) and the world's largest oil producer within the next several years (International Energy Administration, 2013). The energy supply implications of fracking are not limited to the U.S., as this new technique has led to expanded production in Europe, Asia, Australia and elsewhere (Walser and Pursell, 2007).

2.2. Impacts associated with the fracking industry

A number of water-related environmental concerns have arisen around fracking, including surface water treatment and disposal (Volz et al., 2011), aquifer and ground water contamination (Osborn, Vengosh, Warner, & Jackson, 2011), and the competition over water uses in water-scarce regions (Nicot & Scanlon, 2012).

Economically, industry sponsored, non-peer reviewed studies have predicted high levels of economic growth as a result of shale gas development (Considine, Watson, & Blumsack, 2010; Murray & Ooms, 2008; Perriman Group, 2009; Weinstein & Clower, 2009). Development brings with it both jobs and earnings from mineral royalties, with many landowners leasing their land for development. However, Kinnaman (2011) points out that early forecasts are likely overstated due to faulty assumptions and a need for better econometric models. Moreover, Kay (2011) found that inadequate information exists to predict the long-term economic implications of large scale fracking, and that the oft-promoted short term economic gains have a "tenuous" relationship with development's long-term economic prospects:

> Gas development will direct new money into the region, and the prospects for substantial short-term economic gain for some local businesses and property owners are real. [However,]…the rising tide is not likely to lift all boats: there will be losing constituencies among communities and individuals who are displaced or left behind. Moreover, the experience of many economies based on extractive industries is a warning that their short-term gains frequently fail to translate into lasting, community-wide economic development. Most alarmingly, in recent decades credible research evidence has grown showing that resource dependent communities can and often do end up worse off than they would have been without exploiting their extractive sector reserves (Kay, 2011, p. 3).

Previous research suggests that rapid energy resource development—or the "boomtown" effect—can have mixed social and economic effects in affected communities, though the overall impact of this boom and bust cycle is determined by demand, price, and the characteristics of the resource being exploited, as well as technological change and political forces (Bunker & Ciccantell, 2005; Freudenburg & Frickel, 1994). The 'boom' phase can overwhelm local governments, especially if accompanied by a 'lack or lag' in sufficient tax revenue, jurisdictional limitations, and a shortage of staff expertise (Jacquet, 2009, 2014). It can also create conflict between long term and newer residents. Economic impacts are mixed, including stratification of job growth; inflationary and employment effects for non-industry businesses; and mixed economic benefits for different sections of the community (Jacquet 2009). Social impacts that may result include increases in the prevalence of sexual predators in a community (Berger & Beckmann, 2010); higher rates of illicit drug use and domestic violence (Power, 1998); more frequent mental health problems (Bacigalupi & Freudenberg, 1983); and education funding shortfalls (Blevins, Jensen, Coburn, & Utz, 2005).

Increased oil and gas development is not without its merit, however. Natural gas produced from the fracking process is frequently framed as an alternative transition fuel source due to its low lifecycle greenhouse gas emissions. The greenhouse gas footprint of unconventional natural gas development is roughly estimated to be only 56% of that from coal, and only 11% greater than conventional natural gas development (Hultman, Rebois, Scholten, & Ramig, 2011). These low measures of unconventional natural gas production's greenhouse gas footprint have been contested by other scientists who have attempted to account for methane leakage during the production phase (Brandt et al., 2014; Howarth, Ingraffea, & Engelder, 2011; Stephenson, Doukas, & Shaw, 2012). An increase in oil and natural gas supply also has national security implications due to diminished concerns over securing an adequate energy supply overseas (Rosenberg, 2014). Lower energy prices from increased production of natural gas may also lead to a resurgence of manufacturing activity in the U.S. (U.S. Energy Information Administration, 2014).

2.3. Public Perceptions of Fracking

Studies of public perceptions of fracking at a national level indicate that Americans are largely uninformed and undecided about the issue. Among those who have made a decision, attitudes are generally divided (Boudet et al., 2014; Davis and Fisk, 2014; Pew Research Center for the People and the Press, 2012; University of Texas Energy Poll, 2013; Vedlitz, 2012). Boudet et al. (2014) found that people more likely to support fracking tend to be older, hold a bachelor's degree or higher, politically conservative, watch TV news more than once a week, and associate the process with positive economic or energy supply outcomes. On the other hand, women, those holding egalitarian worldviews, those who read newspapers more than once a week, those more familiar with hydraulic fracturing, and those who associate the process with environmental impacts are more likely to oppose it. Similarly, Davis and Fisk (2014) found that women, African-Americans, and urban residents were more likely to oppose fracking; while conservative, rural residents and those who associated fracking with economic growth were more likely to support.

Research into perceptions of fracking in locally-affected areas has shown that community members tend to focus on public health and safety, quality of life issues, and environmental concerns (Anderson & Theodori, 2009). Respondents in the Barnett shale region of Texas predominantly noted issues related to water treatment and transportation, as well as noise and light pollution, risks from increased truck traffic to and from the well sites, and the impact on the overall aesthetic value of the landscape (Anderson & Theodori, 2009). In the Marcellus shale region, local debates have often revolved around themes related to the economic distribution of benefits from development—the "haves and have nots"—where some individuals receive compensation in terms of leases and royalties, while others share the environmental and social costs of development but do not receive such benefits (Jacquet & Stedman, 2011). Theodori (2013) has shown that such attitudes are associated with "very real and very meaningful actions" taken in response to proposed or realized development in Tarrant County, Texas. Individuals with a negative view of the industry, for instance, are more likely to vote against a pro-industry political candidate or contact a local elected official.

3. Literature review

While this study is primarily interested in how spatial factors (current and previous industry experience) influence attitudes toward fracking, a number of other micro-level, demographic factors – as outlined in the literatures on risk perceptions of emerging technologies and attitudes toward LULUs – are relevant. These factors include socio-demographics, "top of mind" associations, and worldviews amongst others (Besley, 2010; Hunter & Leyden, 1995; A. Leiserowitz, 2006; Scheufele & Lewenstein, 2005; Visschers & Siegrist, 2013). For the purposes of our study, we consider these factors in our analysis, as they have already been shown to be relevant in Boudet et al. (2014) using the same dataset. Our goal is to examine whether industry experience affects attitudes toward fracking above and beyond these micro-level and demographic factors.

3.1. Spatial factors

3.1.1. Previous industry experience

A number of studies (Brasier et al., 2011; Freudenburg & Gramling, 1994; McAdam & Boudet, 2012) have examined the role of previous industry experience in shaping public perceptions and behaviors toward energy technologies using case studies of communities or regions affected by development. While no study has attempted to systematically identify the impact of these experiences using national-level survey data on attitudes, as we do here, they each provide relevant insight into the dynamics of how previous industry experience can shape attitudes toward energy development.

For example, Freudenberg and Gramling's (1994) study of public reaction to offshore oil drilling provides insight into how previous industry experience impacts public attitudes. Despite minimal development over the middle part of the twentieth century, Northern California became a hotspot for opposition against offshore oil development, in large part due to a large oil spill in the Santa Barbara Channel in 1969. In contrast to California, the expanding offshore oil program caused an economic "boom" to take place along the Gulf Coast. While Southern Louisiana had experienced extraordinary economic activity during the booming years of offshore oil development, by the early 1990s, the region was entering into the "bust" phase. Despite widespread concerns over the oil industry's role in shaping a depressed economic environment, residents remained attached to the industry, believing it was the best option for long term economic and cultural stability. Despite the struggles brought on by the bust, Freudenberg and Gramling found "no outright opposition" (p. 37) to the oil industry.

Brasier et al. (2011) looked at public attitudes to the fracking industry in four affected counties in the Marcellus shale basin. In discussions with key informants, members of each county referenced the region's experience with the coal industry as shaping their opinions on existing and future fracking development. The boom-bust cycle of the coal industry in this area was a filter through which local residents anticipated potential impacts. Residents recognized that the fracking industry may not remain invested in the community and instead would extract as much of the resource as possible and leave behind a legacy of environmental and social degradation, much like the coal industry of the early and mid-twentieth century.

In a study of community response to 20 different proposed energy facilities around the U.S., McAdam and Boudet (2012) found that previous industry experience – and community context more generally – shape the "interpretive process" by which community members evaluate new energy development. However, the variability in these experiences—as shown above—and how they relate to a larger personal and community context allow for considerably different outcomes. On one hand, areas with greater experience with the energy industry may have suffered from the boom and bust cycles that characterized the Gulf Coast from 1960-1990. Gulf Coast residents recognize the problems associated with relying on the oil and gas industry for jobs, but they remain unable to attract employers in other industries, leaving oil and gas industry as the primary source of quality employment in the area. However, in regions such as central Pennsylvania or California, previous extractive resource industry experience has led to more caution in interpreting new industry activity. As a result, an *a priori* hypothesis about the effects of previous industry experience at the national level remains difficult, thus we offer the following research question:

RQ1: Does previous experience with the oil and gas industry shape current attitudes toward fracking?

3.1.2. Geographic proximity to current fracking activity

While previous industry experience may explain variation in public attitudes to fracking, current experiences with fracking development may also explain variation in attitudes. Opposition to energy facilities has long been defined as a function of proximity to facility, and subsequently categorized as NIMBY or LULU phenomena, but with mixed results (Braunholtz, 2003; Johansson & Laike, 2007; Swofford & Slattery, 2010). These phenomena explain opposition as a function of proximity: the closer a resident lives to energy development, the more likely they are to oppose the facility on self-interested grounds. Yet this explanation remains insufficient, as findings have been inconsistent and vary by energy technology (Devine-Wright, 2005; Jacquet, 2012). On the subject of fracking, proximity to development has appeared to be significant in predicting support for fracking locally (Jacquet, 2012) but only weakly. Thus, we offer the following research question:

RQ2: Does proximity to current fracking development impact attitudes toward fracking?

3.2. Micro-level and demographic factors

3.2.1. Socio-demographics

A number of socio-demographic factors have been shown to affect public perceptions of energy and non-energy technologies (Ho, Scheufele, & Corley, 2011). Gender is one such factor. Men are generally more likely to support emerging technologies than women (Siegrist, Keller, Kastenholz, Frey, & Wiek, 2007). Men are also less likely than women to oppose the siting of coal, natural gas, nuclear, and wind power facilities (Ansolabehere & Konisky, 2009). Public opinion polling has found that men are more supportive of fracking than women (Quinnipiac University, 2012). Several possible explanations have been suggested for this effect, including men holding greater decision making power, women having a stronger role as caregivers, as well as the gendered stratification of income, education, and political orientation (Flynn, Slovic, & Mertz, 1994; Kahan, Braman, Gastil, Slovic, & Mertz, 2007; Satterfield, Mertz, & Slovic, 2004). Similar patterns and explanations exist in the comparison between white and minority groups. Minority groups are more likely to be exposed to environmental hazards and are therefore more likely to oppose threatening facilities (Ansolabehere and Konisky, 2009).

Other socio-demographic factors show relevant, but inconsistent, influence. Older individuals are more likely to oppose new energy technologies (Firestone & Kempton, 2007). Income and education are associated with opposition to natural gas but support for wind power (Firestone & Kempton, 2007; Jacquet, 2012). However, Boudet et al., (2014) found that income and race were not predictors of support or opposition on the issue of fracking. Age, education, and gender were predictive: older individuals and individuals with a bachelor's degree or higher were more likely to support fracking while women were more like to oppose it.

3.2.2. "Top of mind" associations

One way to capture complex perceptions is through the use of "top of mind" associations. "Top of mind" associations are generally aligned with the concept of affective imagery, which is "broadly construed to include sights, sounds, smells, ideas, and words, to which positive and negative affect or feeling states have become attached through learning and experience" (Paul Slovic, MacGregor, & Peters, 1998, p. 3). The use of "top of mind" associations then is a way to capture perceptions of risks and benefits in an efficient manner, as the underlying affect helps to direct “fundamental psychological processes such as attention, memory, and information processing” (Paul Slovic et al., 1998, p. 292.). Such perceptions of risk and benefit have consistently been shown to strongly predict support and opposition to energy development (Boudet et al., 2014; Lesbirel & Shaw, 2005; Pidgeon & Demski, 2012; Visschers & Siegrist, 2013).

“Top of mind” associations are readily accessible, easily recalled, and more likely to be used in decision-making (Keller, Siegrist, & Gutscher, 2006; Lee, Scheufele, & Lewenstein, 2005). Such associations have been used to understand public perceptions of climate change (A.Leiserowitz, 2005), nuclear reactor technology (Keller, Visschers, & Siegrist, 2012), and fracking (Boudet et al, 2014). In the case of new nuclear reactor technology, opponents were more likely to associate nuclear power plants with negative images, such as military applications, nuclear accidents, and radioactive waste disposal, while supporters tended to associate nuclear power with the general appearance of the facility or energy needs. Boudet et al., (2014) found that individuals who associated fracking with the environment were more likely to oppose fracking, while individuals who associated fracking with economic issues such as jobs or energy supply were more likely to support fracking.

3.2.3. Worldviews

Worldviews are “general social, cultural, and political attitudes toward the world” (A. Leiserowitz, 2006, p. 49) These attitudes help explain “how individuals and groups interpret the world in different, yet patterned ways” (A. Leiserowitz, 2006. p. 49.) This concept has been used to explain how risks are perceived and decisions ultimately made around controversial environmental or energy issues. The concept of worldviews is based on the work of Douglas and Wildavsky (1983), who describe worldview types as the product of both acceptance of societal rules governing individual behavior, as well as a person's orientation toward or away from social interaction. This matrix groups individuals within four defined categories: hierarchist, fatalist, individualist, and egalitarian. These orientations can be associated with responses to risks that threaten these worldviews, while these responses are further associated with preferred management objectives for dealing with these risks (Kahan, Braman, Slovic, Gastil, & Cohen, 2009). As an example, egalitarian worldviews lead one to be concerned with social justice, which implies that egalitarians will prefer management goals that ensure there is not an unequal distribution of risks and benefits. On the issue of fracking, egalitarian worldviews have been found to be negatively correlated with support of the fracking industry (Boudet et al., 2014).

3.2.4. Political ideology

Risky energy technologies such as fracking are seen differently according to political ideology (Rothman & Lichter, 1987; Wildavsky & Dake, 1990). Public opinion polling has shown that conservatism is a strong predictor of support for the development of available fossil fuel resources generally, with Republicans and conservatives more supportive of fracking specifically (Pew Research Center for the People and the Press, 2012; Boudet et al., 2014).

3.2.5. Media use

Media coverage has the power to shape how individuals perceive risk and whether or not they are more likely to support or oppose a new technology. Media coverage performs an agenda-setting function wherein media outlets determine what topics and narratives are newsworthy (Flynn, Peters, Mertz, & Slovic, 1998; McCombs & Shaw, 1972). Of course, the mechanisms by which this occur vary greatly (Driedger, 2007; Iyengar, 1991; Krimsky, 2007). On the issue of fracking, Boudet et al. (2014) found that individuals who watch television news once a week or more are more likely to support fracking, while individuals who get their news from a newspaper once or more per week are more likely to oppose fracking.

3.2.6. Familiarity

Familiarity is defined here as the amount of information on fracking that a respondent has been exposed to. This type of familiarity could potentially produce two divergent outcomes. On one hand, low information or familiarity can lead to risks that are "unknown" which can lead to opposition (P. Slovic, 1987). Therefore individuals who are less familiar with fracking would be more likely to oppose it. However, if exposure to media coverage of fracking has largely been negative, more familiarity could lead to stronger oppositional attitudes. In fact, recent polling specific to fracking shows that higher levels of familiarity are indeed associated with opposition (Boudet et al., 2014; Brooks, 2013).

4. Data and Methods

4.1. Data collection

Data for this study were collected from three sources: (1) the September 2012 Climate Change in the American Mind (CCAM) survey, (2) U.S. Geological Survey (USGS) data on locations of historical oil and gas development, and (3) U.S. Energy Information Administration data on locations of current shale plays.

We included four questions about hydraulic fracturing as part of the CCAM survey. Administered by Knowledge Networks, the survey was conducted online from the 7th to the 13th of September 2012. Knowledge Networks recruits a large-scale, nationally representative participant panel using random digit dialing and address-based sampling to ensure that cell phone-only households are also included in the sampling frame. They also provide internet access and computer use for those who require it, while also providing small incentives in order to increase participation. Of an initial 1960 Americans, 1061 completed the survey – a completion rate of 54.1% and a cumulative response rate of 5.2% (Callegaro & DiSogra, 2008). The margin of error was 3% at the 95% confidence level. The CCAM survey took about 10 to 15 minutes to complete. Results are weighted to conform to the demographic structure of the U.S. population. With one exception, all respondent locations were geocoded to latitude and longitude coordinates, allowing for comparisons with the following geospatial datasets. A sample size of 618 was used for the final analysis[1].

The USGS dataset contains geocoded information about oil and gas development in the U.S. from 1900-2005 by decade in one square-mile cells (Biewick, 2008). According to USGS, the information for this dataset was compiled from over 3 million wells documented in IHS Inc.'s PI/Dwights PLUS Well Data on CD-ROM, a proprietary, commercial database containing information for most oil and gas wells in the U.S. (Biewick, 2008). USGS provides the dataset in a geographic coordinate system of North American Datum 1983, which we projected to the Albers equal area conic projection. We selected this particular projection due to its appropriateness for east-west orientations, country size scale, and middle latitudes (ESRI, 2013).

[1] 318 respondents were dropped from the analysis due to answering "do not know" on the survey question pertaining to attitudes toward fracking. Therefore only individuals who indicated a specific attitude were included in this analysis. The remainder of respondents not included were due to missing data in our independent variables.

The U.S. Energy Information Administration (2012) provides geospatial data on the inclusive regions currently experiencing fracking development. These regions included both the "shale basin" – or the area where shale reserves currently exist – and the "shale play" – where reserves are currently under some level of development. In this analysis only the shale play was included due to a lack of availability of precise well data nationally.

4.2. Variable measurements

Table 1 provides a full description of the CCAM survey-derived variables used in the analysis as well as descriptive statistics. Four of these variables require further elaboration: (1) environmental and (2) economic top of the mind associations; (3) worldviews; and (4) attitudes toward fracking.

Top of the mind associations were measured by asking individuals what came to mind when thinking of the word "fracking". These images were categorized and then tested for inter-coder reliability by a collaborating author. An initial subset of 120 entries (11% of the sample) generated a Krippendorf's alpha of .75, where 1.0 indicates perfect reliability. Discrepancies were discussed, revisions made to the coding scheme, and on a second round of analysis an alpha of .91 was given. This indicates strong reliability. Of a previous set of 10 codes, only economic and environmental association codes were used in the analysis due to their significance in a previous study (Boudet et al., 2014). These codes were included as dichotomously coded variables, where any individual who did not associate fracking with economic or environmental issues received a code of '0.'

Worldviews were operationalized using a reduced set of eight questions (Dake, 1991; Peters & Slovic, 1996; Rippl, 2002). Respondents were asked to endorse statements using the scale 1 (strongly disagree) to 4 (strongly agree). Principle components analysis revealed a 2-factor solution that is consistent with previous research. Factor 1 (Eigenvalue ¼ 3.242; 40.5% of variance explained; all factor loadings 4 .79) reflected three questions pertaining to egalitarian worldviews. All three questions were averaged to form a composite index. Factor 2 (Eigenvalue ¼ 2.028; 25.5% of variance explained; all factor loadings 4 .63) reflected five questions pertaining to individualist worldviews. All five such questions were averaged to form a composite index. Only egalitarian worldviews were used in this analysis, however, again due to their significance in previous work with this data (Boudet et al., 2014).

The dependent variables in this analysis is the respondent's attitude toward fracking. Respondents were asked on a five point scale whether they supported (5) or opposed (1) fracking (M=3.02; SD=1.19). Options were also given for "refused", "prefer not to answer", and "do not know." 26% of respondents chose the "do not know" option, and these respondents were dropped from the analysis.

Table 1. Survey-derived variable measurements and descriptive statistics

Variable	*Question(s)/categories*	*Descriptive Statistics*
Age	What is your age?	M=47,SD=17.35
Gender	0=Male 1=Female	Female=52.1%
Educational Attainment	0=Less than bachelor's degree 1=Bachelor's Degree or higher	Bachelor's degree=35.1%
Egalitarian Worldviews	Please tell us whether you agree or disagree with the statements below: 1=Strongly disagree 2=Somewhat disagree 3=Somewhat agree 4=Strongly agree 1) The world would be a more peaceful place if its wealth were divided more equally among nations 2) In my ideal society, all basic needs (food,	M=2.42, SD=.8, α=.76

	housing, health care, and education) would be guaranteed by the government for everyone 3) I support government programs to get rid of poverty	
Political Ideology	In general, do you think of yourself as… 1=Very liberal 2=Somewhat liberal 3=Moderate/middle of the road 4=Somewhat conservative 5=Very conservative	M=3.07, SD=1.05
Media Use	How often do you turn to the following media sources to keep up with current news and world events? Television (traditional or online) Newspapers (print or online) 1=Less than once a month 2=About once a month 3=Several times a month 4=About once a week 5=Several times a week 6=Every day	Television M=4.45, SD= 1.76 Newspaper M= 3.58, SD= 1.98
Familiarity with fracking	How much have you ever heard or read about fracking? 1=Not at all 2=A little 3=Some 4=A lot	M=2.01, SD=1.1
Top of the mind associations	When you think of fracking, what's the first word or phrase that comes to your mind?	Environment: 5.9% Economic: 1.3%
Attitude toward fracking	"Fracking" is a way to extract natural gas from shale rock deep underground. Based on anything you may have heard or read about fracking, do you… 1=Strongly oppose it 2=Somewhat oppose it 3=I'm undecided 4=Somewhat support it 5=Strongly support it	M= 3.02, SD=1.19

Assessing previous industry experience required combining the CCAM survey with available USGS data on historical patterns of oil and gas industry activity. As discussed above, this data came in the form of a raster GIS layer, wherein one square-mile cells contained information about whether oil and gas development was present or not present. Using the "near table" tool in the geographic information system software package ArcGIS, observations were first generated that measured the distance between a survey respondent and any grid cells containing oil and gas industry activity by decade. Then, we generated a measure of total industry experience by decade as a count of all of the grid cells containing oil and gas industry activity within a 15-mile (24-

kilometer) radius during that timeframe.[2] The high number of 0 values (respondents who have no industry activity near their residence) and the small number of individuals who live in extremely high activity areas (>100 grid cells of activity in a 15 mile radius) produced strong positive skewness (skewness statistics ranging from 2.5 to 11.1) in the distribution of these variables. As a result, the natural log was taken for each decade in order to create a more normal distribution (skewness statistics ranging from .82 to 1.4 in the log form). A value of 1 was added to all observations in each decade in order to remove any zero values, which cannot be log transformed.

Due to a lack of adequate national level data on precise well activity in the fracking industry, we accounted for proximity to current shale gas development by dichotomously coding residents by whether they resided in a current shale play. Data defining the boundaries of a shale play was produced using U.S. EIA shapefiles that outline current shale plays in the U.S., as of April 2012, about six-months prior to the administering of our survey. Table 2 provides measurement descriptions and descriptive statistics for these two industry experience factors.

Table 2. Industry experience factors

Variable	Measurement	Descriptive statistics
Previous industry experience	Number of 1 quarter-mile cells containing oil or gas drilling activity within a 15 mile radius of respondents current residence in given decade	
2000-2005[1]		Mean: 7.31 Min: 0 Max: 128

[2] Research on NIMBY and LULU siting disputes has shown that the distance within which a siting controversy generates noticeable perception-level impacts varies considerably. Lober (1995) found a perception-impact area of no more than 1 mile from the disputed site. The concept of a circular buffer of 20 kilometers (12.4 miles) has been used in recent energy siting studies by Braunholtz (2003), Swofford and Slattery (2010), and Warren, Lumsden, O'Dowd, and Birnie (2005). Stoffle et al. (1991), in their assessment of a "risk perception shadow" of a nuclear waste facility, found that perceptions were most strongly affected within a 15-mile "core" but influence could be detected as far away as 35 miles. Considering the relatively consistent findings from several research efforts on the effect of proximity on public perceptions toward energy facilities, we chose a distance of 15 miles as the appropriate distance from within which to measure experience with previous oil and gas industry activity.

		SD: 17.66
1990-1999		Mean: 12.33 Min: 0 Max: 204 SD: 29.47
1980-1989		Mean: 18.94 Min: 0 Max: 254 SD: 39.89
1970-1979		Mean: 15.79 Min: 0 Max: 225 SD: 32.14
1960-1969		Mean: 14.93 Min: 0 Max: 189 SD: 28.10
1950-1959		Mean: 15.30 Min: 0 Max: 179 SD: 32.30
1940-1949		Mean: 11.70 Min: 0 Max: 173 SD: 26.10
1930-1939		Mean: 9.10 Min: 0 Max: 243 SD: 23.13
1920-1929		Mean: 7.55 Min: 0 Max: 258 SD: 22.40
1910-1919		Mean: 3.33 Min: 0 Max: 233 SD: 16.38
1900-1910		Mean: 2.05 Min: 0 Max: 129 SD: 10.57
Shale Play Proximity	1=Residing within current shale play 0=Not residing in current shale play	Within shale play= 16.7%

[1]Data presented here for decade variables is not log transformed so as to reflect true values.

4.3. Data Analysis

Because we wanted to understand the role of industry experience above and beyond previously-examined “control” variables (socio-demographics, top of mind associations, worldviews, political ideology, media use and familiarity), we first ran a model with only those components. Then, we added our measures of previous industry experience and shale play proximity. Due to the ordinal nature of our dependent variable (attitudes toward fracking), we used an ordinal logistic regression model for this analysis (Long & Freese, 2005). Due to high collinearity (pairwise correlation coefficients greater than .75) between the previous industry activity factors, we ran separate models for each decade of our previous industry experience measure. The Breusch-Pagan test for heteroskedasticity was run to test the model's assumption of homoskedasticity. The test statistic indicated a failure to reject the null hypothesis of a normal distribution of variance ($p=.25$). All independent variables were standardized prior to being included in the regression model. The proportional odds assumption was violated in this case ($p<.05$) therefore odds ratios are not used. Dropped observations due to missing data led to a final N of 619 for the regression model.

5. Findings

As shown in Table 3, the results of this study generally supported the findings of Boudet et al. (2014) about the "control" variables included in this study, with the exception of television news consumption[3]. Age, education, conservative political ideology, and economic top of the mind associations each indicated a statistically significant ($p<.05$) positive relationship with attitudes toward fracking. Gender (women), egalitarian worldviews, newspaper use, higher rates of awareness of fracking, and environmental top of the mind associations each indicated a significant ($p<.05$), negative relationship with attitudes toward fracking. Each of these predictor variables was significant across all models.

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[3] Using this same dataset, Boudet et al. (2014) found that television news consumption had a positive relationship with support. Unlike this previous study, we did not to exclude respondents whose answer to the dependent variable was "undecided" (N=290), significantly increasing our sample size.

Previous and current industry activity variables showed mixed results. Previous industry activity was not statistically significant during any time period, while proximity to current fracking activity presents a positive and significant (β=.15-.18, $p<.05$) relationship to support in all but two of the twelve models.[4] A Bayesian information criterion value of 1719 for each of our first two models indicates that adding the shale play proximity variables does not weaken our model or show preference to either (Raftery, 1996).

[4] We tested several additional variables – including mean distance to oil and gas activity and residence in Gulf Coast states (Florida, Alabama, Mississippi, Louisiana, and Texas) – but found them to be insignificant predictors of support.

Table 3. Ordinal logistic regression predicting determinants of fracking support (N=619)[1].

Model	1 β (se)	2 β (se)	3 β (se)
Age*	.31 (.08)	.32 (.08)	.31 (.08)
Gender*	-.24 (.08)	-.25 (.08)	-.25 (.08)
Education*	.16 (.08)	.18 (.08)	.18 (.08)
Egalitarian Worldviews*	-.51 (.09)	-.52 (.09)	-.52 (.09)
Political Ideology*	.45 (.09)	.46 (.09)	.46 (.09)
Television News	.09 (.09)	.10 (.09)	.10 (.09)
Newspaper*	-.27 (.09)	-.27 (.09)	-.27 (.09)
Awareness*	-.26 (.09)	-.27 (.09)	-.27 (.09)
Environmental Associations*	-.57 (.08)	-.58 (.08)	-.58 (.08)
Economic Associations*	.24 (.08)	.23 (.08)	.23 (.08)
Proximity to Shale Play[2]	--	.18* (.07)	.19* (.09)
Previous Industry Experience 2000-2005	--	--	-.03 (.09)
Bayesian IC	1719	1719	--

*Significant at p<.05 across all models.
[1]Dependent variable was coded as 1 = "strongly oppose" and 5 = "strongly support."
[2]Proximity to a shale gas play was significant at p<.05 in all but two time periods, 1910-1919 and 1970-1979.

6. Discussion

While we find limited evidence of the impact of historical oil and gas development on current attitudes toward fracking, GIS analysis indicated that survey respondents within a current shale play were more likely to support fracking, suggesting that proximity to well activity does explain some variation in attitudes toward fracking, in contrast to recent, more local studies on the effect of proximity on attitudes toward fracking (Jacquet, 2012). Higher levels of support among those residing within a shale play may be explained by research on energy boomtowns, which has shown that people in fracking-affected communities are likely to anticipate high levels of economic activity in early stages of development (Thompson & Blevins, 1983). Given that the fracking industry is largely in its early stages, residents in fracking-affected communities may still be in a "honeymoon" phase, wherein they continue to anticipate high levels of economic return from the exploitation of local oil and gas resources.

The method employed here to examine the effect of proximity on attitude raises questions about previous NIMBY studies. The finding that proximity to industry activity is related to higher levels of support runs counter to a long history of NIMBY research which suggests that proximity to development is more likely related to opposition (Schively, 2007), though a number of recent studies have shown that proximity to energy development is at times associated with support, a form of "reverse NIMBYism" (Jacquet, 2012; Warren, Lumsden, O'Dowd, & Birnie, 2005). This "reverse NIMBYism" seems to be associated with renewable energy sources. To our knowledge, this is the first study to link proximity to oil and natural gas development to support for this activity.

The counterintuitive finding that proximity to fracking activity is associated with higher levels of support may be the result of NIMBY researchers tending to be attracted to particularly controversial cases, and therefore NIMBY studies are not as representative of energy development generally. In this study, we effectively examine a broad, national cross section of siting cases rather than focusing on only a single or small number of cases isolated to a particular region. Therefore this study presents a "general" NIMBY case, providing insight into how a larger, more representative population is treating the siting of a controversial energy technology.

It is possible, therefore, that if we were to have examined proximity as a discrete distance to a single, specific facility—as is most often the case in NIMBY studies—we may have seen a different relationship between proximity and support. Similarly, reducing the scale of analysis to the county or city level may yield different results depending on the region where analysis is conducted. However, data for specific well sites nationwide is not publicly available due to inconsistent reporting requirements at the state level, making such analysis difficult at a national level.

The second key finding in this study is that levels of previous industry experience did not predict any variation in fracking-related attitudes. However, while this study does not show previous industry experience to be relevant in explaining current attitudes toward fracking, previous research efforts at smaller scales and via interview methods must not be disregarded. In fact, such literature suggests that such experience often serves a mediating role in the interpretative processes of those most active in such debates, an idea which we did not test here. Such work suggests that a more relevant test might relate to political activism as opposed to general attitude.

6.1 Limitations

One potential issue in this study is the distribution of survey respondents in relation to the distribution of oil and gas activity. Oil and gas drilling largely occurs in rural or semi-rural areas, but our nationally representative survey does not stratify the sample in this way. As a result, we have a survey sample that is largely not in geographic proximity to oil and gas activity, particularly fracking activity, with only 16.7% of respondents living in a shale play. Davis and Fisk (2014) recently found that rural residents were more inclined to support fracking, while urban residents were more likely to oppose fracking. Further studies should account for this rural/urban divide. It is worth noting, however, that recent trends point toward an industry that is increasingly active in metropolitan areas as well as rural areas (Anderson & Theodori, 2009; Jacquet, 2014).

While the survey data used in this study was thorough in collecting socio-demographic data, it was not designed for the purposes of this survey. As such, several potentially relevant variables were not collected in the survey. One issue that has been shown to be critical in similar research is respondent trust in government and industry actors (Freudenburg & Gramling, 1994), which was not included in this survey. We also do not know how long residents have lived in their current community. Thus, we could be evaluating individuals who have simply not lived in an area long enough to understand or experience the impacts of previous oil and gas development. In addition, including a number of outcome variables related to the perceived social-psychological impacts of fracking and related activism would have allowed this study to explain far more about the impacts of previous industry experience rather than merely focusing on attitudes.

One of the primary challenges of this project was determining the appropriate distance at which to measure perceived impact from previous industry activity. While we relied on literature from the field of energy facility siting, which has a robust history of examining the effect of facility proximity on public attitudes, the theoretical justification for the approach used here and in the vast majority of the literature is limited. A more prudent strategy would be to allow respondents to define the impact area as laid out by Stoffle et al. (1991) in their assessment of a contentious nuclear waste facility. This emic definition of the impact zone would provide a richer image of how risk and opportunity is perceived as a function of proximity to development. Similarly, the lack of national-level well data for ongoing fracking activity made a traditional analysis of proximity to a specific energy facility impossible.

6.2 Future Directions

Future research should monitor how proximity to industry activity affects attitudes over time. Previous research on natural resource boomtowns has shown that a range of psychological indicators tend to fluctuate over time as residents adjust to the boom and bust cycle brought on by rapid energy development (Brown, Dorins, & Krannich, 2005; Smith, Krannich, & Hunter, 2001). One could surmise then that support and opposition are likely to also fluctuate over time as residents adjust to various stages of development. Another future opportunity is to link these historical impacts to a number of behavioral responses, including social movement activity or forms of political participation, including letter writing, voting patterns, protest participation, and many others. Understanding public responses to energy development should not end at attitudes. Recent work has shown that respondents reported attitudes affecting different political behaviors, including letter writing and voting (Theodori, 2013). Similarly, using psychometric outcome variables would allow us to paint a much richer picture of how previous and current energy development affects local residents.

We also recommend investigating the relationship between different extractive industries and current energy development. Many of the new energy technologies critical to meeting future energy demand, including wind, solar, and fracking, will take place in areas accustomed to resource extraction industries, though not necessarily the specific proposed industry. Such industries include coal or timber, both of which have prominent histories in regions being affected by new energy technology expansion. These differences suggests a move from "previous industry experience with the same industry" to "previous industry experience with similar industries", as these industries likely experience similar boom-and-bust dynamics that lie at the heart of residents' interpretive process.

The role of previous industry experience may play a critical role in shaping the interpretive process that local residents employ when engaging new industry activity. Previous industry activity may play a large part in shaping a number of socio-psychological factors including personal and community identity, place attachment, and trust in private or public organizations. Even though our findings do not suggest links between historical development and attitudes toward fracking, further exploration of the subject may reveal powerful indicators of public attitudes and behaviors toward energy development in rural areas, where new energy industries including solar, wind, and fracking are set to expand in the near future.

Most importantly, different methodological strategies should be employed to further evaluate the role that previous industry activity has on current attitudes toward fracking development. In this study, a nationally representative sample was used wherein very few respondents (16.7%) live in a fracking affected community. This small sample size and non-stratified population may obfuscate the impact and importance of previous industry experience in shaping fracking-related attitudes in fracking-affected communities. Focused, comparative studies of critical cases may elucidate the impact of previous industry experience further. As the literature review presented here clearly indicates that previous industry experience plays a role in shaping public attitudes, the lack of explanatory power for the previous industry factors may not be indicative of the construct's true influence. Given the scale of this analysis and our relative lack of ability to differentiate between relevant subpopulations or geographic regions, more nuanced approaches – such as more detailed descriptions of experiences with the industry and a variety of social-psychological outcomes – may yield different insights.

6.3 Policy Implications

While this study did not identify any effect from previous industry experience on current attitudes toward fracking, the literature is strong enough to indicate that such experiences are relevant in shaping community responses to energy development, though perhaps not through an effect on public attitudes. Such responses play a critical role in policymaking: community perspectives are essential in developing land use policy, as residents are able to provide what Freudenberg and Pastor (1992) called the "big picture" in comparison with experts' focus on technical details. This is particularly important given recent court rulings which may be shifting power to local municipalities by allowing local governments to use zoning ordinances to control fracking development (Navarro, 2012).

Freudenberg and Pastor (1992) argue that in local conflicts, reducing friction between policymakers and community residents may rest on the ability to understand differences in frames of reference between the two groups. While policymakers may see energy development from a perspective of energy supply and macroeconomic growth, local residents may see a threat in the form of an industry similar to one previously experienced. Closing this perception gap may result in more fruitful long-term policy and reduced local conflict. Schively (2007) argues that empowering "risk bearers" (Kasperson, Golding, & Tuler, 1992) to take ownership of contentious energy projects—exercising greater decision making power surrounding the risks and benefits of the project—can reduce conflict and promote trust in the siting process. This can be achieved by allowing residents to monitor risks themselves by hiring private experts (Kasperson et al., 1992) or through the use of community advisory boards (Bacot, Bowen, & Fitzgerald, 1994).

Given that individuals within shale plays are more likely to support development, advocates and policymakers may wish to implement different communication strategies to individuals near activity from those who are not. These different groups may have different concerns and conceptions of risk, and addressing those issues effectively may require different strategies.

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