Title: Beliefs about impacts matter little for attitudes on shale gas development

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Highlights:

- Previous work suggests attitudes toward 'fracking' are based on specific beliefs
- Our research suggests attitudes may instead *lead to* beliefs about development
- This finding challenges social-psychological assumptions about attitude objects
- Communication on impacts of 'fracking' may do little to affect support/opposition
- Policy should focus on issues beyond the immediate impacts of development

Abstract

Do facts lead to positive/negative views about energy development or vice versa? The answer matters crucially for policy and communication – if perceptions of what is true (beliefs) precede feelings (attitudes), additional information could shape views on an energy technology; yet, if attitudes precede beliefs, the usefulness of communication, either for influencing beliefs or simply making the public more informed, is far less clear. A long history of social-psychological research asserts that individuals' beliefs predict their attitudes on environmental issues. Nevertheless, other theories intimate the reverse – attitudes shape beliefs, specifically on newly emergent, controversial topics. We investigated whether attitudes (i.e., support and opposition) about the contentious issue of shale gas development stem from or lead to beliefs about development. We collected data from random-sample surveys – of residents in the Marcellus Shale region and of a national US sample. Factor analyses and structural equation modelling lead us to question the dominant assumption that beliefs precede attitudes – the reverse, or a recursive relationship, appears more likely. Broad values and place attachment precede attitude formation more reliably than beliefs about impacts do – suggesting need for a larger focus in energy policy on core values and the ways in which development could foster or compromise these values.

Keywords: shale gas; hydraulic fracturing; beliefs; attitudes; prediction; causality

1. Introduction

Shale gas development via high-volume, slick-water hydraulic fracturing (often called "fracking"[1]) is an increasingly hot political issue in the USA, Canada, much of Europe, and beyond (Boersma and Johnson 2012, Bomberg 2017, Malakoff 2014, Mazur 2016, Montpetit and Lachapelle 2017, Van de Graaf *et al.* 2017). Researchers, politicians, and partisans alike have sought to understand why people form the opinions they do about this issue. A review of public perceptions research on this issue reveals, in general, slightly more support for shale gas development than opposition in the United States, although high percentages of survey respondents are commonly undecided in their attitudes towards development and substantial regional variation in attitudes exists (Thomas *et al.* 2017). Some research suggests that attitudes towards development have become more divisive over time (Mazur 2016), or that opposition has increased over the years (Perry 2012, Pew Research Center 2013). In Europe, a review of public perceptions of shale gas development in the UK, the Netherlands, Germany, and Poland indicated that with increased exposure to the issue, undecided members of the public increasingly opposed development (Lis *et al.* 2015). In this research, we focus on antecedents of attitudes (i.e., support and opposition) in the US, on both a national level and in areas close to substantial shale gas development.

Research on this topic has proliferated exponentially over the decade. Perhaps due to the heavy policy focus on regulating and managing "impacts", much research focuses on impacts associated with development. Scientists have afforded particular attention to effects on:

[1] Note: We use the term 'shale gas development' throughout this article to refer to the set of processes and associated effects that attend this form of energy extraction/development. Whilst no term is perfect, social-psychological research into how this word is used provides nuanced discussions of why to avoid use of 'fracking' (see Evensen *et al.* 2014, Evensen 2016c, Wolske and Hoffman 2013).

1) Water quality (Llewellyn *et al.* 2015, Olmstead *et al.* 2013, Rahm and Riha 2012, Stokstad 2014, Vengosh *et al.* 2014, Vidic *et al.* 2013) – contamination has been shown to occur, often due to surface spills, but also due to cement well casings that have failed;
2) Air quality and air pollution (Alvarez et al. 2012, Allen et al. 2013, Moore *et al.* 2014, Newell and Raimi 2014, Schrag 2012, Schwietzke *et al.* 2016, Zavala-Araiza *et al.* 2015) – a fierce debate exists over whether life-cycle emissions from shale gas development contribute to or mitigate climate change, with the answer depending on quality of regulations, measurement approach, leaky infrastructure, and the energy sources that shale gas either displaces or augments; further, local air emissions (e.g., VOCs, ozone, and NO_x) produced by gas field infrastructure have become a concern due to public health;
3) Biota and ecosystems (Buchanan *et al.* 2017, Drohan *et al.* 2012, Kiviat 2013, Souther *et al.* 2014, Milt *et al.* 2016) – well pads and pipeline corridors have caused much habitat disruption and increased the amount of edge habitats, preferencing some species over others; additionally, water withdrawals from streams at certain times of year can critically reduce flows needed for survival of aquatic species;
4) Human health (Adgate *et al.* 2014, Jacquet and Stedman 2014, Kibble *et al.* 2013, Kovats *et al.* 2014, Mitchell *et al.* 2016) – a range of potential human health problems have been associated with the build out of a shale gas industry, including respiratory problems, issues arising from potential water contamination, endocrine disruption, the alleged possibility of cancer, psycho-social stress due to rapid changes in way of life, and occupational hazards for industry workers; due to the difficulty of establishing causality

between the industrial operations and health problems, little is known for certain in this area;

5) Local and regional economics (Fry *et al.* 2015, Kinnaman 2011, Melikoglu 2014, Paredes *et al.* 2015, Weber 2012) – job creation, economic growth, and increases in municipal and state-level taxes have been linked to shale gas development, although the magnitude of benefit has not been commensurate with predictions; concerns about negative economic outcomes exist, including increases in rental costs, crowding out of previously viable economic sectors, reductions in tourism, and reductions in property value;
6) Community well-being (Evensen 2015, Evensen and Stedman 2017, Fernando and Cooley 2016a, 2016b, Jacquet 2014, Jacquet and Stedman 2014, Seeliger *et al.* 2016, Sangaramoorthy *et al.* 2016) – rapid changes in small, often rural communities can accompany a quick build out of the shale gas industry and bring a large, often transient, population to these areas; this can benefit communities by affording new services and economic and social opportunities, but also has been linked to diminished well-being due to marred aesthetics (visual, auditory, olfactory), loss of place meaning, changes in community character, and increased crime.

As the academic world continues to investigate and publish findings focused on the impacts of shale gas development, our research suggests that beliefs about impacts of development may contribute little to development of attitudes about shale gas development (i.e., support and opposition).

In addition to the numerous studies that examine the impacts themselves, empirical research on *public perceptions* of shale gas development often assumes that the primary predictors of attitudes about shale gas development are beliefs about impacts associated with

development (Braiser *et al.* 2011, Jacquet and Stedman 2013, Kriesky *et al.* 2013, Ladd 2013, Schafft *et al.* 2013, Theodori 2009, 2013, Wynveen 2011; for a review see Thomas *et al.* 2017b). These claims stem from a theoretical tradition that assumes beliefs about the effects of a new process or action will lead to an individual's support or opposition (Fishbein and Ajzen 2011). Based on these often implicit theoretical assumptions, empirical research frequently employs data analysis techniques that reveal only correlational relationships; yet when discussing the implications of such findings, the relationships are treated as causally predictive.

Our survey research and data analysis suggest these assumptions may not be appropriate – attitudes about shale gas extraction (i.e., support or opposition) may *lead to* beliefs about the impacts of this relatively novel form of energy development, or, at minimum, recursive feedback loops might exist that mean causality is not uni-directional. Debates of this sort draw attention to research that repeatedly establishes the importance of public perceptions and social structures in shaping views on energy production technologies and processes (Kasperson and Ram 2013, Rayner 2010, Sovacool 2014, Stephenson 2016, Webler and Tuler 2010, Wüstenhagen *et al.* 2007).

If the causal direction of the relationship between attitudes and beliefs about shale gas development is not as straight-forward as many researchers have assumed, this would have substantial implications for social-psychological research broadly and particularly for communication and policy on this topic. Politicians, policy makers, and partisans seek to understand why members of the public feel as they do about shale gas development. They want to know how to regulate shale gas development in a way that responds to public concerns – this has often focused on ways to address specific impacts – take, for example, the heavy focus on "impact assessments" in regulation on shale gas development and other energy development

technologies. However, if beliefs about impacts are not the key driver of attitudes about development, responding directly to impacts might not be the most effective way to address public concerns – we consider alternatives in the discussion below. Perhaps more cynically, many politicians and partisans also want to know whether certain messaging strategies and/or approaches to engagement in the policy process will or will not be effective in changing attitudes towards development.

In this article, we provide evidence from two random-sample surveys. Our exploratory factor analyses and structural equation modelling suggest that the commonly asserted pathway needs—at minimum—re-engagement (in this debate in particular, and within social psychology about emergent attitudes and beliefs more generally). After shedding light on the relationship between beliefs about and attitudes towards shale gas development, we explore other factors that might foster support and opposition. We discuss implications of these findings for social psychological research and for policy and communication about shale gas development. We begin, however, by briefly reviewing social-psychological theories that posit a causal pathway between attitudes and beliefs – some with beliefs predicting attitudes and others with attitudes predicting beliefs.

2. Theoretical Background

2.1. Defining attitudes and beliefs

Whilst quotidian colloquial conversation does not always distinguish between attitudes and beliefs, these concepts are importantly distinct in social-psychology; equally important is whether beliefs lead to attitudes or vice versa. Beliefs are the 'cognitive component of attitudes' (Heberlein 2012, p. 15); they are statements, presumed to be true, although the actual truth of the

statement does not matter. What matters is presumption of truth to the holder of the belief. Heberlein (2012, p. 16) explains, 'what makes it a belief is the absence of emotion'. Attitudes, on the other hand, 'differ from knowledge because they are driven by the love-hate, good-bad aspect of emotion'. This emotive basis for attitudes is often called 'affect' in social-psychology (Slovic *et al.* 2004). Attitudes, then, are valenced (positive, negative) views towards a specific object.

2.2. Causal relationships between beliefs and attitudes

Within Fishbein and Ajzen's (2011) reasoned action approach and its antecedents (i.e., the theory of planned behaviour and the theory of reasoned action), beliefs about specific objects and issues are posited as leading to attitudes about those objects/issues (hence the label *reasoned* action). This causal relationship has been exceptionally influential in social psychological research for over four decades (e.g., according to Google Scholar, the initial monograph on this topic by Fishbein and Ajzen [1975] has been cited over 44,000 times). Fishbein and Ajzen (2011, 96-97) contend explicitly:

> Within our reasoned action framework, attitudes follow directly from beliefs about the attitude object. Generally speaking, we form beliefs about an object by associating the object with various characteristics, qualities, and attributes…Consistent with Fishbein's expectancy-value model, we assume that attitudes toward an object are formed automatically and inevitably as new beliefs are formed about the object.

Whilst Fishbein and Ajzen do write that this causal direction occurs "general speaking", implying that this causal pathway might not dominate in all instances, use of this theory for empirical research functionally suggests that beliefs precede attitudes.

Other noted researchers in this area of social psychology have established the importance of specific beliefs and attitudes about environmental issues for predicting behavioural intentions, but they do not posit a causal relationship between attitudes and these beliefs. The distinction between *general* beliefs and *specific* beliefs about and attitude object/issue is important here. Stern and colleagues (1995a, 726) equate general beliefs with worldviews and assert, "We view worldviews as causally antecedent to more specific beliefs, which in turn are antecedent to personally held norms, intentions, and other proximate causes of particular actions". Stern and Dietz argue that "specific beliefs" and attitudes represent a single step in the causal progression from values to behaviours (Dietz *et al.* 1998, Stern *et al.* 1995a). General beliefs relevant to shale gas development could be, for example, that fossil fuels harm the planet, or that industrial activity creates additional employment – these beliefs *could* apply to shale gas development, but they do not comment on it directly. Specific beliefs, for example, are that shale gas development damages water quality or increases local tax revenue. A third type of belief is *evaluative* beliefs; these are general beliefs that are tied to values. These beliefs "say or imply that something is better than something else", but still lack the emotive component of attitudes (Heberlein 2012, p. 16) – for example, renewable energy is better than fossil fuel energy. Stern and Dietz forward that, *general* beliefs predict both *specific* beliefs and attitudes, but these scholars do not commit to a causal direction from specific beliefs to attitudes or vice versa.

Stern's and Dietz's work falls broadly into research on Values-Beliefs-Norms theory. This theory posits that values filter and thus are causally prior to beliefs; furthermore, beliefs can activate norms, which then precede action/behaviour (Henry and Dietz 2012). Values-Beliefs-Norms theory has been useful for explaining how self-interest, altruism, and altruism for the environment can explain pro-environmental action. Whilst Values-Beliefs-Norms theory is a

useful theory of causality that benefits from much empirical validation, it does not commit to a causal direction between attitudes and *specific* beliefs. Stern and colleagues do contend, "individuals construct attitudes to new or emergent attitude objects by referencing personal values and beliefs about the consequences of the objects for their values," but beliefs about values exist at the general level (Stern *et al.* 1995b).

Another theoretical perspective that illustrates the connections between values, worldviews, and specific beliefs, but that does not commit to the relationship between attitudes and specific beliefs is the cultural cognition thesis. As Kahan and colleagues (2011) explain, 'cultural cognition refers to the tendency of individuals to fit their perceptions of risk and related factual beliefs to their shared moral evaluations of putatively dangerous activities'. Kahan and Braman (2006, 28) also postulate,

> Essentially, cultural commitments are prior to factual beliefs on highly charged political issues. Culture is prior to facts, moreover, not just in the evaluative sense that citizens might care more about how gun control, the death penalty, environmental regulation and the like cohere with their cultural values than they care about the consequences of those policies. Rather, culture is prior to facts in the cognitive sense that what citizens believe about the empirical consequences of those policies *derives* from their cultural worldviews.

The cultural cognition thesis's attention to the primacy of broad values and commitments (worldviews) over cognitive evaluation of facts likens this approach to the Value-Beliefs-Norms theory; it has most to say about the relationship between *general* beliefs and *specific* beliefs, but less about where attitudes fit in this causal progression.

To ground this discussion of general and specific beliefs in the context of shale gas development, consider the following two general beliefs and one evaluative belief could precede attitude formation about shale gas development: (1) extractive industries harm the environment, (2) shale gas development is an extractive industry, and (3) protecting the environment is important. In this article, we do not evaluate these sorts of general beliefs (e.g., shale gas development in an extractive industry), but rather examine specific beliefs about individual effects of shale gas development (e.g., development causes air pollution or creates jobs). Our primary question here is whether these specific beliefs or attitudes come first in the minds of individuals when they consider shale gas development. Figure 1 presents a simplified schematic of the general causal progression between key concepts in (1) theories asserting that specific beliefs precede attitudes and (2) those maintaining the opposite. Note that the schematic takes a strong causal view and does not depict theories such as the values-beliefs-norms theory or the cultural cognition thesis that do not commit to a causal direction between specific beliefs and attitudes.

2.3. Attitudes predicting beliefs

Environmental sociologists recognise that cases exist in which "causality went backward" (Heberlein 2012, 22), with attitudes leading to beliefs instead of vice versa. Whilst this observation highlights that this reverse causality is not a new observation, use of the term "backwards" also confirms the general assumption in social-psychology that beliefs precede attitudes. Heberlein suggests that this reverse tendency is most likely when the attitude object is a highly charged, emotional topic. Social representations theory is consistent with this perspective. This social-psychological theory efforts to explain how common sense meanings

surface in society in relation to complex scientific phenomena; it contends that public discourse leads to the emergence of overarching representations towards objects and processes (Moscovici and Duveen 2001, Wagner and Hayes 2005). These representations often take the form of newly emergent attitudes (i.e., evaluations of the novel object or process). The theory contends that social representations are especially common for novel, contentious attitude objects. Only after emergent representations form can individual cognitions (e.g., beliefs) mould the representations further. Moscovici (1984), the founder of social representation theory, writes,

> Thus, it is easy to see why the representation we have of something is not directly related to our manner of thinking but, conversely, why our manner of thinking, and what we think, depend on such representations, that is on the fact that we have, or have not, a given representation.

He contends that social representations (e.g., societally-derived summary views of an object or process) *precede* our personal, individualised thinking, rather than our thinking leading to the representations. Therefore, it is less individual *reasoning* than societal discourse that leads to emergence of attitudes; in this sense individual cognitions (beliefs) follow emergence of a societally-produced attitude (Bugden *et al.* 2017). The dominance and precedence of societal forces, as opposed to individual cognition, is perhaps unsurprising due to the genesis of social representations theory from Émile Durkheim's sociological concept of collective representations (Pickering 2000).

A second, psychologically-grounded, theory – motivated reasoning – also supports the existence of "backwards causality". Motivated reasoning contends that particularly on novel, partisan issues, people will often form beliefs about facts based on the facts' consistency with their attitude about the issue. Druckman (2012, 200) defines motivated reasoning as:

> the tendency to seek out information that confirms priors (i.e., a confirmation bias), to view evidence consistent with prior opinions as stronger (i.e., a prior-attitude effect), and to spend more time counterarguing and dismissing evidence inconsistent with prior opinions, regardless of their objective accuracy (i.e., a disconfirmation bias).

Neurobiological (Westen *et al.* 2006) and experimental psychological studies (Boiney *et al.* 1997, Dawson *et al.* 2002) offer evidence consistent with the existence of motivated reasoning. Particularly on an issue as contentious and partisan as shale gas development (Choma *et al.* 2016, Clarke *et al.* 2015, 2016, Evensen 2016b), motivated reasoning might lead specific beliefs about impacts to derive from attitudes about the newly emergent phenomenon. A third theory, the advocacy coalition framework, makes similar claims about highly polarising issues leading to "biased assimilation", where new information is only internalised if it is consistent with prior attitudes (Hoffman and Henn 2008). Henry and Dietz (2012) explain that "polarization of networks [of actors] restricts social learning across competing coalitions", revealing that the individuals/groups with whom one associates might prevent certain beliefs from forming.

Whilst each focusing on different cognitive processes, cultural influences, or aspects of social structure as the motivating forces, the aforementioned theories in this section intimate that beliefs and acceptance of facts (e.g., knowledge of impacts of development) can form subsequent to and be dependent on emergent attitudes. This suggests a need to reconsider the often-cited assumption – which has launched myriad research inquiries – that beliefs lead to attitudes. We must note that the theories we rely on here are often applied particularly to novel/emergent and contentious phenomena. This is also the context in which we conducted our research.

2.4. Attitudes and beliefs about shale gas development

In published academic research on attitudes and beliefs about shale gas development, we have found several researchers who assume—explicitly or implicitly—that formation of specific beliefs precede production of attitudes, but none that posit the reverse relationship. Whilst these authors did not set out to test the reasoned action approach explicitly, they each relied on the assumptions about beliefs predicting attitudes inherent in that model. Kriesky and colleagues (2013, 233) are the most forthcoming – they state explicitly that their statistical regressions reveal that (1) support for shale gas development is "due to" perception of economic impacts and possession of a lease and (2) their correlational results identify "concern for environmental and public health impacts" as "contributing to opposition". Jacquet and Stedman (2013, 463) assert that impact perception "explains" attitudes (positive or negative) to gas drilling. Theodori (2009) examines perceptions of whether thirty impacts are becoming better or worse, with the assumption that beliefs about impacts are evaluated individually – which would only be the case if they were not derived from a positive or negative attitude towards development.

3. Methods

We designed two surveys to measure public attitudes and beliefs about shale gas development. We mailed the first survey to a stratified random sample of residents in 34 municipalities in the Marcellus Shale region of southern New York and northern Pennsylvania (17 municipalities in each state, total N=1202). Data collection for this survey occurred during October-November 2013. With an output of 18.5 billion cubic feet of natural gas per day as of February 2017, the Marcellus Shale is the largest natural gas producing region in the USA (US EIA 2017). Ninety-two percent of gas reserves in the basin are estimated to lie under

Pennsylvania and New York (US EIA 2012). Notably, New York State now has a ban on high volume hydraulic fracturing for natural gas; nevertheless, this ban, instated by Governor Andrew Cuomo in December 2014, purportedly on the basis of environmental and health impact assessments, postdates our data collection by over a year. During our survey, New York State had a moratorium in place on development whilst its Department of Health was collecting additional information on impacts.

Our second survey was a nationwide internet survey administered via the online survey firm Qualtrics; it was sent to individuals obtained from Qualtrics's online panels (N=1625). The sample was split evenly on sex and all respondents were at least 18 years of age; the geographic distribution of respondents was consistent with distribution of the national population. Data collection for this survey occurred between 16-19 September 2014. The two surveys together allowed us to examine the structure of beliefs about impacts in an area close to intense shale gas development and in a sample of the general population nationally.

We report here primarily on two questions that were asked in both surveys. The first question measured attitudes about shale gas development by asking respondents in the Marcellus Shale region survey, "Considering everything, do you support or oppose shale gas development?" In the national sample survey we asked, "Do you think that extracting natural gas from shale in the United States should or should not be allowed?" The Marcellus Shale region survey contained a 6-point Likert-type scale; the national sample survey contained a 4-point Likert-type scale. The second question asked, "How likely do you think the following effects of shale gas development are (in areas with development)?" In the Marcellus Shale region survey we asked about twenty impacts; in the national sample survey we asked about a

sub-sample of thirteen of these same impacts. We include full question wording and response options in Appendices A and B.

3.1. Marcellus Shale region survey

To design the questions for this survey, we conducted a content analysis of regional newspaper coverage in the Marcellus Shale region and 47 interviews with individuals heavily involved in discourse on shale gas development. We mailed the survey to a random sample of 147 households in each of 17 municipalities in southern New York (NY) and 17 municipalities in northern Pennsylvania (PA). We selected study communities for the survey by expanding the regions surrounding the six communities we used for our interviews. We included a range of urban and rural areas within each of the six regions and across regions. We selected communities that varied on a range of relevant variables (e.g., passage of legislation supporting or opposing shale gas development, number of wells drilled, amount of land leased, demographic statistics, political leaning, etc.). The survey was pilot tested with a focus group (N=10) of area residents to assess intelligibility of question wording and meaning. Minor adjustments were made as a result.

We finished designing the survey in late July 2013. At this same time, we purchased a random sample of names, addresses, and telephone numbers for residents in our selected municipalities. The sample was compiled by cross-referencing the most recently available US Postal Service records with telephone book white pages. We were able to exclude seasonal addresses, addresses that had been vacant for over 90 days, and 'drops' (single delivery points that service multiple residences) from the sample. We included all other address types (i.e., regular street addresses, PO Boxes, street addresses that actually go to PO Boxes, rural routes,

and deliveries contracted out to third parties by the USPS). We mailed surveys in a four-wave mailing (i.e., survey, reminder, second survey, second reminder).

The survey was mailed to 4,998 households; 629 of those surveys were returned as undeliverable (345 in NY and 284 in PA). Therefore, with 1202 respondents (637 from NY and 565 from PA), the adjusted response rate for the entire sample was 28%. The sample varied from population means in terms of age, sex, and education. The sample was more educated, more male, and older than the general population. Therefore, we used 2010 US Census data for the six counties in NY (averaged across these counties) and four counties in PA (again, averaged) to generate proportional weights which we applied to the data set for all subsequent analysis (Table 1).

3.2. National (USA) sample survey

The original wording and format appear in Appendix B for each question we report on from our national sample survey. Many of these questions replicate items from the Marcellus Shale region survey. A pilot test of 100 responses was reviewed by Qualtrics (the online panel firm with which we contracted for our sample) and the authors to check for problematic patterns that could suggest difficulties with question interpretation. To ensure that data quality was maintained in the online survey, Qualtrics only included in the final data set respondents who spent at least eight minutes responding to the survey. Review of the pilot test data for patterns such as repeatedly picking the same answer (especially in battery-style questions), multiple skipped items, and early termination established that this was a reasonable threshold to exclude respondents who were likely engaging in strong satisficing (Krosnick and Presser 2010).

Response rates are not indicative when using online quota-sampling as non-response cannot be easily defined and demographic information should be consulted instead (Dillman, 2007). The survey approximated the US national population with respect to sex, regional distribution (by state), and age (of individuals 18 years and older). Qualtrics draws respondents from online panels; therefore, quotas were applied to responses to ensure that the resulting responses match the national averages demographically. Because the sample was nationally representative based on population distribution across the US, areas with low population had very little representation in the survey (e.g., states such as the Dakotas, Wyoming, and Montana, and all rural areas). This means that areas with shale gas development (or potential for development) contributed few respondents. The survey should be viewed as reflecting national views on this topic, not the views of communities exposed to development or with potential for development. The total number of responses was N=1625; fifty-seven people exited the survey prematurely, equating to an adjusted completion rate of 97%.

3.3. Data analysis

We first conducted an exploratory factor analysis of respondents' perceived likelihood of impacts occurring (principal axis factoring with promax rotation; we chose promax rotation after initially examining the factor structure – we applied an oblique rotation method due to high correlations between factors). We applied this analysis to both data sets. This allowed us to investigate whether impacts separated along environmental/economic/social category lines (as previously suggested) or whether they pooled as positive and negative impacts – potentially indicating that a positive or negative attitude towards shale gas development may have emerged before beliefs about impact likelihood formed.

Following the exploratory factor analyses, we use structural equation modelling (SEM) to further analyse the data from the Marcellus Shale survey. SEM permits hypothesis testing about theoretically-posited causal relationships. SEM allows one to conduct confirmatory factor analyses whilst at the same time regressing the latent variables created from the factor analyses on each other. These models use confirmatory factor analysis (CFA), not the exploratory factor analysis (EFA) that is most common for dimension reduction. CFA includes the added constraint that all factor loadings other than those explicitly specified as loading onto a factor are set at zero, whereas EFA permits all variables included in the model to freely load on each factor.

Myers and colleagues (2013) used path analysis (which is identical to SEM in how structural regression pathways are modelled and interpreted, but which simply does not include CFA) to investigate effectively the causal direction of the relationship between personal experience and belief in the reality of global warming. Goldberger (1973, 2) further illustrates why structural equation modelling is appropriate for the type of analysis we conducted in this article, whilst the regression analysis conducted by many previously scholars working in this area is inappropriate:

> In a structural equation model each equation represents a causal link rather than a mere empirical association. In a regression model, on the other hand, each equation represents the conditional mean of a dependent variable as a function of explanatory variables.

The strong causal assumptions that come with structural equation models – assigning values of zero to all non-specified pathways – distinguishes regression analysis from structural equation modelling.

Whilst structural equation modelling cannot *prove* causal links, the statistical assumptions do allow for testing theoretically-justified hypotheses. As Bollen and Pearl (2013) explain,

> Failure to fit the data [in a structural equation model] casts doubt on the strong causal assumptions of zero coefficients or zero covariances and guides the researcher to diagnose, or repair the structural misspecifications. Fitting the data does not "prove" the causal assumptions, but it makes them tentatively more plausible.

We stratified our sample across the municipalities to which we sent our surveys in the Marcellus Shale region; respondents were assigned to one of 34 mutually-exclusive categories, representing each of the municipalities included in the survey. Stratification is a way of dealing with complex survey data; it creates a single model for the whole survey population that accounts for non-independence of observations within the individual communities – generating more accurate estimates of standard error than one would receive without stratification (Oberski 2014, Stapleton 2006).

4. Results

4.1. Factor analysis, Marcellus Shale region survey

Our exploratory factor analysis generated two factors with eigenvalues greater than 1.0 (10.3 and 2.0), leading to a total explained variance of 62% (Table 2). A reliability analysis of the fourteen items that loaded clearly onto factor 1 produced a Cronbach's alpha of 0.96. A reliability analysis of the six items loading clearly onto factor 2 produced a Cronbach's alpha of 0.85. An un-rotated analysis produced a similar result with two factors clearly emerging.

Similar findings to this factor analysis emerged in Theodori's (2013) research on public perceptions of shale gas development. Theodori interpreted the findings as revealing that economic items loaded onto one factor and that both environmental and social items loaded onto the other factor. This is consistent with how impacts are generally conceived of in research on public perceptions of energy development – separating impacts into environmental, economic, and social categories. We interpret our findings differently. The composition of the two latent constructs from the factor analysis reveals that factor 1 is comprised *entirely* of negative impacts (risks) and factor 2 is made up of *only* positive impacts (benefits) (see Table 2). Positive economic and social effects pooled together in our factor analysis; negative environmental, economic, and social effects pooled together (the first seven impacts listed in Table 2 are economic; the next ten are social; the final three are environmental).

4.2. Factor analysis, national sample survey

To further explore the generalisability of the findings across a broader geographic scale and a population potentially less exposed to intense discourse about shale gas development, we conducted our national sample survey. An exploratory factor analysis (principal axis factoring with promax rotation) of the perceived likelihood of impacts occurring from this survey generated two factors with eigenvalues greater than 1.0 (4.8 and 3.0), leading to a total explained variance of 61% (Table 3). As in the first factor analysis, one relatively high cross-loading emerged (0.39 on factor 2 for an item in factor 1). This relatively high cross-loading was for "increased traffic"; whereas increased traffic is often perceived as a negative impact, it is also a clearly visible sign of (positive) increased economic activity.

A reliability analysis of the eight impacts in factor 1 produced a Cronbach's alpha of 0.90. A reliability analysis of the five impacts in factor 2 produced a Cronbach's alpha of 0.79. The thirteen items in this factor analysis split onto the same components as did these same thirteen items in the first factor analysis. Furthermore, once again, factor 1 is comprised entirely of negative impacts (risks) and factor 2 is made up of only positive impacts (benefits).

The structure of these two latent factors (i.e., risk and benefits) and the high alpha values of the subsequent reliability analyses, replicated across the two surveys, suggests that survey respondents conceivably assessed likelihood of impacts *based on* their attitude towards shale gas development – the perceived likelihoods of bad things happening were all similar and the likelihoods of good things happening were all similar, but different from the likelihoods of the negative effects. If the primary underlying latent factors consistently represent whether the impact is positive or negative, it logically follows that respondents did not actively assess the likelihood of each individual impact and *then* select a response option based on that belief. Rather, the respondents more likely used their positive or negative attitude towards shale gas development as a heuristic on which to base a determination of impact likelihoods. Therefore, this factor analysis provides initial evidence that beliefs about shale gas development may not have preceded attitudes about development, as is often assumed.

4.3. Structural equation modelling

The factor analyses create the expectation that people who oppose shale gas development will think negative impacts are more likely and positive impacts are less likely, vice versa for people supporting shale gas development. We employed structural equation modelling to investigate this hypothesis and explore further which direction of the causal relationship

(between support/opposition and beliefs about impacts) better fits the survey data. Testing the relationship between attitudes and specific beliefs about shale gas development in the Marcellus Shale region survey in both causal directions revealed substantially better model fit for the direction from attitudes to beliefs. This model had adequate to good model fit, whilst the model with the reverse pathway had poor to adequate model fit (Table 5).

We used the municipality from which each respondent came as a stratification variable in our model to account for the complex structure of the survey data. We constructed a latent variable from the three measures of support/opposition in the Marcellus Shale region survey; a confirmatory factor analysis (CFA) revealed very high factor loadings, indicating a single underlying construct (see Figure 2). We followed this CFA with two second-order CFAs, to generate latent factors representing beliefs about risks and benefits. Finally, we added structural pathways from the latent support/opposition variable to the latent variables representing beliefs about risks and beliefs about benefits (i.e., this model reflects the casual direction predicted by the theories postulating attitudes leading to specific beliefs).

The SEM presented in Figure 2 has good model fit (see model 1 in Table 5). We constructed the same model, except we changed the direction of the two structural regression pathways, from beliefs about risks and beliefs about benefits *to* support/opposition (model 2 in Table 5). We also ran a recursive model that included these structural regression pathways going in both directions (i.e., with feedback loops; model 3 in Table 5).

The measures of fit for the three SEMs in Table 5 indicate, across all four fit indices, that the model positing support for and opposition to shale gas development as causally prior to beliefs about impacts has better fit than the model in which these relationships are reversed. Additionally, the fit index values for model 1 indicate good (CFI, SRMR) or adequate fit

(RMSEA), whilst those same indices for model 2 indicate adequate (CFI, RMSEA) or poor fit (SRMR) (Hooper *et al.* 2008). On each index, the fit is minutely better for the recursive model compared to the model depicted in Figure 2. Therefore, as per Bollen and Pearl's (2013) advice on interpretation of structural equation model fit, the results do not "prove" the attitudes to beliefs direction or recursive causality, but they make both of these alternative causal pathways "tentatively more plausible" than causality from beliefs to attitudes.

4.4. Factors predicting support/opposition

The foregoing results provide a logical, plausible prospect that a causal pathway from attitudes about shale gas development (e.g., support or opposition) to beliefs about impacts is at least as reasonable—if not more so—than the reverse. This prompts the question of which factors *do* predict attitudes about development, if not specific beliefs about impacts.

In both surveys we included several demographic variables and general beliefs that we thought might shape views about shale gas development (recall that all the theories considered earlier position general beliefs and values prior to attitudes [see Figure 1]). In the Marcellus Shale region survey, political views, two general beliefs, and one evaluative belief (i.e., a value attached to a general belief) explained 41% of the variation in support/opposition for shale gas development (linear regression; Table 6). The general beliefs were measured by level of agreement with the following statements: (1) "The balance of nature is very delicate and easily upset by human activities" (this is an item from the New Ecological Paradigm scale) and (2) "A first consideration of a good political system is protection of private property rights". The evaluative belief was measured by agreement with the statement, "My community is special to me as is; I would not want anything to change." Inclusion of these items as independent

variables in a linear regression is theoretically justified because there is no equivocation in social psychological theory over the assertion that general beliefs and worldviews are casually prior to attitudes (Dietz *et al.* 1998, Stern *et al.* 1995a).

The national sample survey included these same items listed above, save the evaluative belief (due to the survey being conducted in areas beyond those exposed to the reality of shale gas development or those having potential for development). The three variables, once again, were highly significant and explained 14% of the variation in support for and opposition to shale gas development (Table 6).

5. Discussion and Implications

The factor analyses reveal that a wide range of beliefs about shale gas development (relating to several environmental, economic, and social impacts) represent only two core constructs – risks and benefits (positive and negative effects). This is in contradistinction to common research approaches that focus on domains of impacts (e.g., environmental, economic, and social). If survey respondents treat as a single construct the likelihood of a large group of negative effects occurring and treat likelihood of positive effects occurring as a separate group, this offers reasonable evidence for those individuals assessing the likelihood of an effect occurring *based on* whether they perceive shale gas development as good or bad. If development is bad, negative effects are more likely; if development is good, positive effects are more likely. This causes us to question the common assumption in social-psychological research and public perceptions research on shale gas development that beliefs about impacts affect attitudes. The data suggest, rather, that attitudes are directly causally preceded by (without mediation by specific beliefs): (1) general beliefs, such as those about the environment and property rights, (2)

evaluative beliefs, such as about one's community, and (3) worldviews such as political identification. The location of these other variables in the causal directionality is consistent with the social-psychological theories reviewed earlier (see Figure 1); the change from some of those theories is that the location of specific beliefs no longer precedes attitudes in the causal chain. Note: due to the strong fit of the recursive structural equation model (i.e., the model with the feedback loops), we are not asserting that attitudes necessarily precede beliefs, only that beliefs seem not to precede attitudes.

5.1. Implications for communication

The finding that beliefs about impacts of shale gas development potentially do not precede attitude formation implies that strategic communication about this issue will be more difficult than academics and the public have asserted (see, for example, UK Government claims on this front [Evensen 2017, Williams *et al.* 2017]). A logical conclusion from previous research on public perceptions of shale gas development, which suggests knowledge about impacts *leads to* support and opposition, is that sharing additional facts about impacts could help shift support and opposition more in line with "reality" (following the common language of information deficit approaches [Stedman *et al.* 2016]). Nevertheless, consistent with other recent findings (Evensen 2017, Fernando and Cooley 2016b, Kroepsch 2016, Williams *et al.* 2017), our research cautions that providing the public with additional information about impacts will do little to shape attitudes towards or beliefs about shale gas development. Rather, our findings further support the results and recommendations that emerged from the National Research Council (2014) workshops on shale gas development. The experts on shale gas development who participated in those workshops jointly concluded that due to the contentious nature of this issue,

trust is often compromised – complicating provision of reliable information. They suggested that attention to precaution, transparency, and consultation/collaborative decision making could meaningfully forward discourse on this topic (see also: Lis and Stasik 2017, Mrozowska *et al.* 2016, Thomas *et al.* 2017b). To the extent that factual information is not particularly useful in forwarding perceptions of this issue, awareness of and involvement in the process by which decisions are made might be beneficial for providing more nuanced understanding of the issue. Indeed, research has shown concerns about procedural justice to be amongst the leading normative claims shaping perceptions of shale gas development (Cotton 2013, 2017, Evensen 2015, 2016a, Whitton *et al.* 2017).

The one notable exception to additional information likely having little to no effect on attitudes towards shale gas development is in the instance where attitudes demonstrably do not yet exist. In the introduction, we reported that many survey respondents in national-scale surveys in the US answered that they are undecided on this issue. This is true to an even greater extent in surveys conducted in the United Kingdom (Andersson-Hudson *et al.* 2016, DECC 2016, Stedman *et al.* 2016). Recent UK-based research – an experiment embedded in a survey – revealed that provision of additional facts about the effects of shale gas development might shift attitudes for initially ambivalent populations (Whitmarsh *et al.* 2015).

Some researchers investigating public perceptions of shale gas development have asserted that construal level theory might play a role in shaping the types of beliefs upon which individuals rely (Clarke *et al.* 2015, 2016, Evensen and Stedman 2016), thus affecting the types of communication that could be effective at different geographical scales. This theory focuses heavily on individual cognitive processes and, thus, is of the genre of theory assuming that beliefs are important for attitude formation. The nuance arises in that it predicts that the closer

one is to an issue psychologically (i.e., the closer one *perceives* himself/herself to be to an issue), the more concretely he/she will evaluate the issue. The further away from an issue one perceives himself/herself to be, the more abstract the processing will be. Therefore, construal level theory would presumably predict higher reliance on specific beliefs within communities affected by shale gas development and higher reliance on general beliefs at the broad national level. Indeed, the aforementioned researchers found evidence of this (Clarke *et al.* 2015, 2016, Evensen and Stedman 2016), with the association between general beliefs (worldviews) and attitudes being more pronounced in national level survey samples and the association between specific beliefs and attitudes more notable at the local level. The currently study, however, also revealed a stronger association between specific beliefs and attitudes at the local level. We contend that the strength of the relationship itself does not reveal anything about the direction of causation. Our research suggests that theories relying heavily on active individual cognitive appraisals to explain attitudes are likely not as useful as theories that examine the role of social structure and communal discourse. Communication about shale gas development would more readily target the roots of attitude formation by focusing on the shared historical and cultural experiences that shape values and general beliefs than on specific cognitions about shale gas development itself.

5.2. Implications for policy

If general beliefs and values shape attitudes before specific beliefs about impacts can affect them, and attitudes in turn precede the specific beliefs, this means that historical experience (Bugden *et al.* 2017) and affective experiences could matter quite a lot in shaping support and opposition to shale gas development. This is because the constructs with the most influence in the causal chain are not specific facts linked to shale gas development itself, but

rather are broad feelings and desires, such as trust in an information source (Thomas *et al.* 2017a, Williams *et al.* 2017) and moral concern for fairness and justice (Cotton 2017, Evensen 2016). In this sense, the quantitative findings herein parallel key themes recently revealed through qualitative research on public perceptions shale gas development.

In-depth interviews in the US and Canada by Evensen and Stedman (2017) demonstrated that people in areas with shale gas development did not care about impacts of development, per se, but rather they cared about how things they value – such as peace, quiet, local beauty, and community and family structure – would be affected by development. General beliefs about industrial activity relate more readily to these broad values than do specific beliefs about pollution and economic activity brought on by shale gas development. Similarly, deliberative workshops in the US and UK in areas where shale gas development is not (yet) occurring showed that a palpable lack of trust in government and industry actors was a key influence on support and opposition as well as on beliefs about impacts of development (Partridge *et al.* 2017, Thomas *et al.* 2017a). Comparing the current study with these qualitative findings suggests impact assessments and regulation on shale gas development that is preoccupied with addressing specific impacts of development might do better to focus more broadly on the values that these impacts ostensibly affect. Regulation could also ensure that policies are implemented in a way (e.g., fair, transparent, and consultative) to secure the trust of affected populations.

If policy makers wish to address their constituents' concerns and interests, they will need to craft policy that is farther reaching than simply focusing on the set of impacts potentially associated with shale gas development. For example, Evensen and Stedman (2017) suggest that 'jobs' per se might not matter that much, but rather, local residents often desire increased employment to stem population decline and to keep youth local. Therefore, the appropriate

departure point for policy becomes an assessment of options for stemming population decline – this could include a range of options for increasing employment as well as a focus on the condition of local services and aesthetics, for example. This approach to policy proceeds from the values and evaluative beliefs of communities exposed to development, rather than using impacts as the foundation for policy. This may sound like a small shift, but really represents a transformation in the policy approach on energy projects, especially when one considers the sometimes 1000+ page impact assessments that form the bedrock of regulation on energy development.

Impacts are still important; "facts" of what effects will likely occur from shale gas development are an essential – but insufficient – component of any policy decision. Policy makers would be able to respond better to the needs and interests of their constituents if they knew the root rationales for why people hold the views they do in relation to shale gas development/fracking. Whilst many such variables likely differ across communities, regions, states, and nations potentially affected by shale gas development, our two surveys show that some variables are relevant across geographic scales (i.e., a national sample and a sample within communities proximate to development). The general beliefs and worldviews in Table 6 could be used as a point of departure for investigation of factors that influence attitudes on development. The importance of values and evaluative beliefs, that do not seem to be meaningfully mediated by specific beliefs, suggests substantial value in communities undertaking a strategic planning process to identify the most relevant values and evaluative beliefs that the local population desires to guide the community moving forward. Such knowledge could be of use to local decision makers when questions of energy development arise; it could offer insight on whether such projects fit with the ethos of the community or not.

5.3. Implications for theory and research

Social psychological research broadly, and particularly related to investigation of public perceptions of energy development, has a tendency to either: (1) explicitly contend that specific beliefs (e.g., about impacts) predict attitudes (e.g., support and opposition) or (2) implicitly assume that studying impacts and perceptions of impacts will help clarify why people care about an issue. Based on our findings, this heavy focus on beliefs and impacts is concerning. To move forward, social-psychological research needs to examine more critically the role that specific beliefs play in shaping attitudes (and vice versa), particularly about novel attitude objects. We recommend remaining vigilant to alternative causal possibilities, rather than simply affirming the assumption—explicit or tacit—in much of social psychology that specific beliefs predict attitudes. Furthermore, whilst enhanced natural and physical scientific knowledge about shale gas development is certainly necessary, one should not accept uncritically that this increased awareness will have much, if any, effect on public perceptions of shale gas development.

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Table 1: Proportional weights for survey data

NY (N = 637)

	Population %	Respondent %	Weight
Male, 18-44, less than bachelors	0.185	0.052	3.56
Male, 18-44, bachelors+	0.053	0.046	1.15
Male, 45+, less than bachelors	0.182	0.23	0.79
Male, 45+, bachelors+	0.068	0.203	0.33
Female, 18-44, less than bachelors	0.17	0.046	3.70
Female, 18-44, bachelors+	0.06	0.04	1.50
Female, 45+, less than bachelors	0.214	0.203	1.05
Female, 45+, bachelors+	0.068	0.179	0.38

PA (N = 565)

	Population %	Respondent %	Weight
Male, 18-44, less than bachelors	0.178	0.051	3.49
Male, 18-44, bachelors+	0.028	0.026	1.08
Male, 45+, less than bachelors	0.238	0.329	0.72
Male, 45+, bachelors+	0.051	0.172	0.30
Female, 18-44, less than bachelors	0.154	0.037	4.16
Female, 18-44, bachelors+	0.039	0.019	2.05
Female, 45+, less than bachelors	0.264	0.24	1.10
Female, 45+, bachelors+	0.048	0.125	0.38

Table 2: Factor analysis for likelihood of impacts occurring, Marcellus Shale region survey (N = 961)

Variable	Factor	
	1	2
Increased jobs for locals	.108	**-.916**
Short-term local economic growth	.268	**-.768**
Long-term local economic growth	-.157	**-.729**
Lowered property values	**.483**	.246
Lower taxes locally	-.093	**-.369**
Less tourism locally	**.607**	.059
Landowner income from leasing / royalties on gas	.080	**-.617**
Increased traffic	**.871**	-.497
Worse road quality	**.777**	-.026
Changes in community character	**.906**	-.214
Decreased local beauty	**.803**	.115
Decreased quality of outdoor recreation	**.753**	.176
Increased crime	**.746**	-.122
Decreased peace and quiet	**.828**	-.037
Increased stress	**.767**	.115
Decreased personal / family health	**.624**	.273
Increased energy independence (nationally)	.022	**-.591**
Decreased air quality	**.686**	.227
Decreased water quality	**.681**	.264
Decreased fish and wildlife health	**.690**	.260

Extraction Method: Principal Axis Factoring.
Rotation Method: Promax with Kaiser Normalization.
Rotation converged in 3 iterations.

Table 3: Factor analysis for likelihood of impacts occurring, US sample survey (N = 1619)

Variable	Factor	
	1	2
Increased jobs for locals	-.049	**.800**
Short-term local economic growth	.155	**.572**
Long-term local economic growth	-.287	**.662**
Lowered property values	**.617**	-.017
Landowner income from leasing / royalties on gas	.073	**.641**
Increased traffic	**.481**	.392
Changes in community character	**.579**	.333
Decreased peace and quiet	**.745**	.138
Decreased personal / family health	**.821**	-.051
Increased energy independence (nationally)	-.028	**.615**
Decreased air quality	**.786**	-.103
Decreased water quality	**.884**	-.116
Decreased fish and wildlife health	**.871**	-.119

Extraction Method: Principal Axis Factoring.
Rotation Method: Promax with Kaiser Normalization
Rotation converged in 3 iterations.

Table 4. Variables in the structural equation model in Figure 2

Measured Variables
community – Do you support or oppose shale gas development in your community?
state – Do you support or oppose shale gas development in your state?
nation – Do you support or oppose shale gas development in the USA?

Composite Variables (likelihood * effect)	health – Decreased personal / family health
jobs – Increased jobs for locals / our children	energyin – Increased energy independence
shorteco – Short-term local economic growth	airqual – Decreased air quality
longeco – Long-term local economic growth	waterqua – Decreased water quality
propval – Lowered property values	fishwild – Decreased fish & wildlife health
taxes – Lower taxes locally	
tourism – Less tourism locally	**Latent Variables (circles)**
leaseroy – Personal income from leasing / royalties	support – Support/opposition across 3 levels
traffic – Increased traffic	risks – 14 negative impacts
roadqual – Worse road quality	aesthet – 3 aesthetic impacts
commchar – Changes in community character	charactr – 5 community character impacts
beauty – Decreased local beauty	healthy – 4 health-related impacts
outrec – Decreased quality of outdoor recreation	environ – 3 environmental impacts
crime – Increased crime	benefits – 6 positive impacts
peace – Decreased peace and quiet	growth – 3 economic growth-related impacts
stress – Increased stress	

Table 5. Model comparisons, Marcellus Shale residents survey (N = 1180)

Standardized parameter estimates			
	Model 1	Model 2	Model 3
risks on support	-0.842*	---	-0.837*
benefits on support	0.718*	---	0.200*
support on risks	---	-0.713*	0.006
support on benefits	---	0.422*	0.617*
Measures of fit			
χ^2 (d.f.)	938.4* (217)	1288.9* (217)	897.0* (215)
CFI	0.959	0.939	0.961
RMSEA	0.053	0.065	0.052
RMSEA (90% C.I.)	0.050 – 0.057	0.061 – 0.068	0.048 – 0.055
SRMR	0.039	0.187	0.038

*p < 0.001, ‡p < 0.01, †p < 0.05

Table 6. Variables in linear regressions predicting support/opposition (N = 967)

Variable	Standardized Parameter Estimate [Marcellus Shale survey]	Standardized Parameter Estimate [US survey]
Balance of nature is delicate and easily upset	-0.402*	-0.283*
Important to protect private property rights	0.261*	0.197*
Like community 'as is'; not desire change	-0.199*	-----
Political views (1-7, liberal–conservative)	0.170*	0.149*

*$p < 0.001$
Marcellus Shale survey Model $R^2 = 0.41$
US survey Model $R^2 = 0.14$

Appendix A: Marcellus Shale survey

The original wording and format appear below for each question we report on from our Marcellus Shale survey.

Please let us know whether you agree or disagree with the following statement about your community.

	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
My community is special to me as it is; I would not want anything to change.	□	□	□	□	□	□

We're interested in your thoughts on impacts of shale gas development. Check two boxes in each row, one for each question.

	How *likely* do you think the following effects of shale gas development are?			
	Not at all likely	Not very likely	Likely	Very likely
Increased jobs for locals	□	□	□	□
Short-term local economic growth	□	□	□	□
Long-term local economic growth	□	□	□	□
Lowered property values	□	□	□	□
Lower taxes locally	□	□	□	□
Less tourism locally	□	□	□	□
Landowner income from leasing / royalties on gas	□	□	□	□
Increased traffic	□	□	□	□

Worse road quality	□	□	□	□
Changes in community character	□	□	□	□
Decreased local beauty	□	□	□	□
Decreased quality of outdoor recreation	□	□	□	□
Increased crime	□	□	□	□
Decreased peace & quiet	□	□	□	□
Increased stress	□	□	□	□
Decreased personal / family health	□	□	□	□
Increased energy independence	□	□	□	□
Decreased air quality	□	□	□	□
Decreased water quality	□	□	□	□
Decreased fish & wildlife health	□	□	□	□

Considering everything, do you support or oppose shale gas development in the following areas? Check one per row.

	Strongly Oppose	Oppose	Slightly Oppose	Slightly Support	Support	Strongly Support
In your community	□	□	□	□	□	□
In your state	□	□	□	□	□	□
In the USA	□	□	□	□	□	□

Please let us know whether you agree or disagree with the following statements. Check one per row.

	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
A first consideration of a good political system is protection of private property rights.	□	□	□	□	□	□
The balance of nature is very delicate and easily upset by human activities.	□	□	□	□	□	□

How would you describe your political views? Circle one.

Very Liberal	1	2	3	4	5	6	7	Very Conservative

Appendix B: US sample survey

The original wording and format appear below for each question we report on from our US sample survey.

Do you think that extracting natural gas from shale in the United States should or should not be allowed?

- ❍ Definitely should be allowed (1)
- ❍ Probably should be allowed (2)
- ❍ Probably should NOT be allowed (3)
- ❍ Definitely should NOT be allowed (4)
- ❍ Don't know (5)

How likely do you think the following effects of shale gas development are (in areas with development)?

	Not at all likely (1)	Not very likely (2)	Likely (3)	Very likely (4)
Increased jobs for locals (1)	❍	❍	❍	❍
Short-term local economic growth (2)	❍	❍	❍	❍
Long-term local economic growth (3)	❍	❍	❍	❍
Lowered property values (4)	❍	❍	❍	❍
Landowner income from leasing / royalties on gas (5)	❍	❍	❍	❍
Increased traffic (6)	❍	❍	❍	❍
Changes in community character (7)	❍	❍	❍	❍
Decreased peace and quiet (8)	❍	❍	❍	❍
Decreased personal / family health (9)	❍	❍	❍	❍
Increased energy independence (nationally) (10)	❍	❍	❍	❍
Decreased air quality (11)	❍	❍	❍	❍
Decreased water quality (12)	❍	❍	❍	❍
Decreased fish and wildlife health (13)	❍	❍	❍	❍

Please let us know whether you agree or disagree with the following statements:

	Strongly disagree (1)	Disagree (2)	Slightly disagree (3)	Slightly agree (4)	Agree (5)	Strongly agree (6)
A first consideration of a good political system is protection of private property rights (1)	❍	❍	❍	❍	❍	❍
The balance of nature is very delicate and easily upset by human activities (2)	❍	❍	❍	❍	❍	❍

Do you currently have an oil or gas lease on your property?

❍ Yes (1)

❍ No (2)

Have you ever previously had a gas or oil lease?

❍ Yes (1)

❍ No (2)

Q21 In general, how would you describe your own political viewpoint?

❍ Very liberal (1)

❍ Liberal (2)

❍ Slightly liberal (3)

❍ Moderate (4)

❍ Slightly conservative (5)

❍ Conservative (6)

❍ Very conservative (7)