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The Structure of Attitudes Towards Shale Gas Extraction in the United Kingdom

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Abstract

Shale gas extraction is a highly controversial process. Despite significant proven or potential reserves, public reaction to extraction have often been negative. In some cases, this has prevented exploration. In this paper, we investigate the structure of public attitudes to shale gas extraction in the context of the United Kingdom, using a dedicated survey of 4,992 respondents. We find that public attitudes to shale gas extraction have a unidimensional structure, such that all questions about the virtues and limitations of extraction are treated as a single issue. Nonetheless, this general structure masks two distinct attitudinal structures. Those with more familiarity with shale gas have a very strong unidimensional attitudinal structure, while those with the least familiarity have a two-dimensional attitudinal structure; representing distinctions between perceived positive and negative attributes. This suggests an important role for information in conditioning responses to shale gas, a factor with implications for how government addresses policy relating to shale gas extraction.

Keywords: Hydraulic fracturing, Shale gas, Attitudes, Mokken scaling, United Kingdom

1. Introduction

Hydraulic fracturing, more commonly referred to as 'fracking', is the primary method used to access natural gas contained within the shale layer approximately 3,000 meters below the surface[1]. Fracking is controversial; proponents of fracking point to increased energy security and potential economic benefits, while critics remain concerned particularly about potential environmental impacts of fracking (Andersson-Hudson et al., 2016, Stephenson, 2015, Boudet et al., 2014, Davis and Fisk, 2014, Howell, 2018, Evensen et al., 2017). There have been well-publicised protests against the application of the technique, including notable direct-action protests against specific drilling sites (Harvey, 2013, Vaughan, 2017).

Notwithstanding the political controversy, at present very little is known about the *structure* of public attitudes towards issues related to shale gas. That is to say that we do not presently know whether individual responses to questions related to shale gas are reflecting a series of distinct individual concerns, and so there is little systematic structure within an individual's responses, or if instead responses are primarily reflecting some smaller number of broader concerns where an individual's responses are largely driven by those broader attitudes. More generally, attitudes to environmental issues and policies have previously been shown to be associated with a variety of social, political, and demographic variables; including political ideology (Harring and Sohlberg, 2017, Clements, 2014, McCright et al., 2016), 'green' self-image (Lacasse, 2014), knowledge and education, gender, and age (for a review see (Gifford and Nilsson, 2014, Bidwell,

[1] Hydraulic fracturing often requires horizontal drilling through the shale layer to access pockets of natural gas. Water, sand and chemicals are pumped at high pressure through the borehole to create fissures within the shale layer to access the shale gas. It has been suggested that this procedure causes small earthquakes.

2016). In terms of attitudes to shale gas extraction in particular, attitudes have been shown to co-vary with gender, class, and political party support (Andersson-Hudson et al., 2016), as well as varying by country (Evensen et al., 2017), and level of knowledge (Howell, 2018). While this research is extremely helpful for elaborating differences in levels of support for different environmental policies in general and understanding differences in levels of support for fracking in particular, it tells us little about the underlying nature of attitudes, particularly in terms of how attitudes are structurally inter-related. The question, in this regard, is whether the public consider the range of benefits and challenges associated with fracking as individual concerns, from which they make judgements based on the perceived balance of positives and negatives, or whether they have much coarser views of the process analogous to fracking being 'positive' or 'negative'. There is a small amount of work looking at this question in relation to shale gas, notably Evensen and Stedman (2017) who examine the relationship between (cognitive) beliefs about the impacts of shale gas development and (non-cognitive) attitudes towards it, on the basis of regional and national surveys in the US. Using factor analysis they find that many beliefs articulated about the impact of shale gas development 'represent only two core constructs- risks and benefits'. As Evensen and Stedman argue, this matters because

> 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 (Evensen and Stedman, 2017, 16-17).

Here we probe a similar question, but crucially do so (1) in the context of a country where shale gas extraction is in its infancy (the UK), and (2) using a methodological approach to assess the number of constructs that underlie the data that is more formally appropriate for survey data.

Moreover, while various studies are able to show that attitudes to shale gas co-vary with political attitudes, they are not able to indicate whether the nature of the attitudes varies, or whether the interpretation of questions about such attitudes co-varies. This may be particularly important in the context of education, where research has shown that respondents with a greater degree of knowledge are more likely to reflect current scientific opinion of fracking than respondents with less knowledge (Howell, 2018: 728). This lack of information has important policy consequences. While we know something about public attitudes to shale gas, from surveys and from such things as protest activity (e.g. BEIS, 2018, O'Hara, et al, 2014, Bomberg, 2017b), without knowing how public beliefs and attitudes are structured, the government, the shale gas industry, and environmental groups are unable to engage in a meaningful debate with the public about fracking. If the public are open to considering the full range of benefits and limitations to fracking as individual concerns, governments may seek simply to ameliorate individual concerns and enhance benefits, such as through proposals to offer financial compensation to local councils affected by fracking as proposed by the Conservative government in the United Kingdom (UK). However, if members of the public have much coarser view then strategies for public engagement must take a different form. A similar point is made in Evensen and Stedman (2017, 19), who note on the basis of their findings from the US that, '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.'

Our substantive findings show that among the population as a whole, there is clear evidence of a unidimensional structure to issues associated with shale gas extraction; a finding that contrasts with Evensen and Stedman's finding of a two-dimensional structure in the US (2017). The UK public has a view whether or not fracking is 'positive' or 'negative', as a single issue, rather than a more detailed view about the strengths and limitations of the process. In this sense, respondents use a single overarching understanding of the benefits or limitations of shale gas as a heuristic to consider a wide range of strengths and limitations of the process. However, this general finding masks two different attitudinal structures. There is an even stronger unidimensional structure among respondents who correctly identified shale gas extraction from a description of the process, which can be considered a basic form of knowledge of, or familiarity with, shale gas extraction. There is a two-dimensional structure separating out 'benefits' and 'limitations' of fracking among respondents who did not answer this question correctly. These two dimensions are distinct and are very weakly inter-related. This therefore suggests that information – or the sources of information – about shale gas has had a galvanising influence on attitudes to shale gas, rather than a moderating influence. Such a finding would be consistent with work on the phenomenon of motivated reasoning (Nir, 2011; Strickland et al, 2011) which has been applied to the contentious issue of shale gas development (Evensen and Stedman, 2017).

2. Fracking in the United Kingdom

Shale gas has become increasingly important as a source of energy, particularly within the United States where it accounted for 67% of natural gas production in 2015 (USEIA, 2016). At the same time, interest in shale gas as a potential source of energy has increased internationally (Hefley and Wang, 2016, Stephenson, 2015); notably within the UK, which is believed to have significant reserves of shale gas (Andrews, 2013, although the proportion of these reserves that is recoverable is not yet clear), and where the government has been keen for exploration to take place (Stephenson, 2015, Conservative Party, 2015, Conservative Party, 2017). There has been no commercial extraction within the country to date, although Cuadrilla is now hydraulic fracturing at a pilot project for commercial extraction at Preston New Road in Lancashire (Walker, 2018). Despite new drilling permits being issued in 2016 in England, the procedure has been indefinitely suspended in Scotland. Exploratory drilling in Lancashire in 2011 was halted after the discovery of a potential causal connection between the process of fracking within the region and two small earth tremors (Green et al., 2012).

The process of fracking is highly controversial in the UK, and support for shale gas extraction fell notably between 2012 and 2016 (Vaughan, 2016, although the final wave of the BEIS tracker that included the question on support for shale gas (wave 25, April 2018) showed a marginal increase in support over wave 23 (November 2017)). A primary obstacle to shale gas extraction in the UK is public resistance to the procedure. This public resistance, coupled with the possibility of significant recoverable reserves of shale gas, makes the UK a particularly compelling case to study. At the same time, concerns relating to shale gas extraction in the UK mirror, to a large extent, those

expressed in the United States (Andersson-Hudson et al., 2016, Evensen et al., 2017); although some researchers have noted differences in the politics of shale gas in these countries, as the agency of pro- and anti-shale groups is exercised within different institutional environments (Bomberg, 2017a)

This paper assesses whether members of the UK public associate shale gas extraction with the following issues: earthquakes, cheap energy, contaminated drinking water, clean energy, energy security, economic benefits and lower greenhouse gas emissions. These are coded as dichotomies, where not associating shale gas with positive attributes or associating it with negative attributes is coded consistently. This allows for a consideration of the structure (and inter-relationships) of both positive and negative attitudes towards shale gas extraction simultaneously. These issues are used to inform our main research question: does the UK public consider the issues associated with shale gas outlined above as one overarching issue or separate issues?

3. Data and Methods

The data used come from the University of Nottingham shale gas survey. These data were collected by YouGov using their online panel between 28th of September and 3rd of October 2016 and provide a sample of 4,992 UK adults. The sample is broadly representative of UK adult population (for a detailed discussion about the Nottingham surveys see Andersson-Hudson et al., 2016, O'Hara et al., 2014).

The data are analysed with Mokken scale analysis, an Item Response Theory (IRT) model, which is employed to measure the latent dimensionality of the data (for a discussion, see (Mokken, 1971, Niemöller and van Schuur, 1983, van Schuur, 2011, van

Schuur, 2003). Mokken scale analysis is somewhat similar to factor analysis and allows for structurally assessing connections between variables going beyond only an analysis of correlation. Where two variables are shown as being structurally interconnected, this implies that they share an important underlying driver - analogous to the factors discovered in factor analysis. While factor analysis itself is a popular approach to understanding the structural interconnections between variables, it is inappropriate for the analysis of ordinal survey items of the kind analysed here (Van der Eijk and Rose, 2015). Indeed, when analysing survey items, factor analysis systematically tends towards creating more dimensions than is necessary.

Mokken scale analysis calculates several statistics of interest. The item H (H_i) represents the interconnection between a variable and all the variables within that scale; and the scale H represents the interconnection between a set of items as a whole (Mokken, 1971, Niemöller and van Schuur, 1983). Within Mokken scale analysis, a coefficient larger than 0.3 is usually taken to indicates a substantively important connection between variables, coefficients larger than 0.5 are usually taken to indicate strong connections (Mokken, 1971, van Schuur, 2011, van Schuur, 2003). The clustering provided by a Mokken scale analysis can be analysed in terms of its internal reliability (termed rho), in the same way Cronbach's Alpha can be computed to evaluate the reliability of a scale; similarly to Alpha, values over 0.7 considered to indicate a reliable scale (Niemöller and van Schuur, 1983, van Schuur, 2003).

The Mokken model is applied to variables indicating whether respondents do or do not associate shale gas with: earthquakes, cheap energy, contaminated drinking water, clean energy, energy security, economic benefits and lower greenhouse gas emissions. In

this analysis, each of these variables is recoded such that higher values are more negative towards fracking. Because the Mokken scale model cannot evaluate cases with missing data, listwise deletion is used for any case with a missing value on one of the seven perceptions evaluated. Further, 'don't know' responses are treated as missing values. While the reasons for 'don't know' responses are interesting in and of themselves, it is not the primary aim to evaluate these here. While sometimes it is preferable to treat 'don't know' answers as if they were a middle category between positive or negative substantive responses (Van der Eijk and Rose, 2015), here this would make the data harder to analyse because there are important non-substantive reasons for 'don't know' responses that are inherently not structurally related to other attitudes. Nonetheless, evaluating the data with 'don't know' responses treated as if they formed a middle category produces substantively similar results, albeit with some expected reductions in the apparent interconnections between the items (analysis not shown here).

To evaluate the Mokken model, the R package 'mokken' (Van der Ark, 2007, van der Ark, 2012) is used.[2]

4. Results

The entire sample for which there are complete observations (n=1,387) is analysed. The results of this analysis are shown in Table 1. Contrary to the findings by Evensen and Stedman (2017) from their factor analysis of US data, these results clearly show a strong

[2] Data and code required to replicate the analysis are available upon request.

interconnection between all the variables, regardless of whether they tap perceptions which are ‘positive’ or ‘negative’ towards shale gas extraction. This suggests that in general the UK public have one orientation towards shale gas extraction and use this orientation to inform views about whether or not shale gas is associated with any particular positive or negative outcome, regardless of the individual question which is presented to them. In effect, the general finding implies that some people think shale gas extraction is ‘bad’, and so therefore associate it with negative outcomes and also do not associate it with positive outcomes. On the other hand, other respondents think that shale gas extraction is ‘good’, and so therefore do not associate it with negative outcomes and do associate it with positive ones. For people who have mixed views, their propensity to think positively or negatively about any individual aspect is conditioned by their overarching view. Those who are more positive are more likely to answer positively to every question about shale gas extraction than those who are less positive.

Table 1

Scale number	Variable	Mean	Item *H*	Standard error
1	Associate shale gas with Earthquakes (1 = No 2 = Yes)	1.660	0.555	0.021
1	Associate shale gas with cheap energy (1 = Yes 2 = No)	1.461	0.617	0.019
1	Associate shale gas with contaminated drinking water (1 = No 2 = Yes)	1.655	0.599	0.019
1	Associate shale gas with clean energy (1 = Yes 2 = No)	1.681	0.669	0.018
1	Associate shale gas with energy security (1 = Yes 2 = No)	1.497	0.632	0.018
1	Associate shale gas with economic benefits (1 = Yes 2 = No)	1.430	0.703	0.018
1	Associate shale gas with lower greenhouse gas emissions (1 = Yes 2 = No)	1.601	0.624	0.017

Scale H = 0.628 (SE = 0.014), N=1387, rho=0.88, alpha=0.87
Table 1. Mokken scale analysis of shale gas issues for all respondents

However, while this structure is substantively very strong, it masks an interesting distinction between respondents who are able to correctly identify shale gas from a description and respondents who are not. Respondents were asked to answer the following question before proceeding to the full survey:

> This is a fossil fuel, found in sedimentary rock normally more than 1000 meters below ground. It is extracted using a technique known as hydraulic fracturing, or 'fracking'. Is this fossil fuel: a) Boromic gas b) Coal c) Xenon gas d) Shale gas e) Tar-sand oil f) Don't know.

The focus here is on the respondents who answered the question correctly and identified shale gas, and those who did not (including 'don't know' responses). In total, there are 1,218 complete cases where the respondent correctly identified shale gas, and 169 cases where they failed to do so.

The results of the scale analysis for respondents who correctly identified shale gas is presented in Table 2. As can be seen, the results are even stronger than when all respondents are included. Those who answer this question correctly have a very strong view of all the items relating to a coherent 'attitude towards shale gas extraction'.

Table 2

Scale number	Variable	Mean	Item *H*	Standard error
1	Associate shale gas with Earthquakes (1 = No 2 = Yes)	1.668	0.604	0.022
1	Associate shale gas with cheap energy (1 = Yes 2 = No)	1.458	0.655	0.020
1	Associate shale gas with contaminated drinking water (1 = No 2 = Yes)	1.660	0.649	0.019
1	Associate shale gas with clean energy (1 = Yes 2 = No)	1.690	0.708	0.020
1	Associate shale gas with energy security (1 = Yes 2 = No)	1.501	0.678	0.018
1	Associate shale gas with economic benefits (1 = Yes 2 = No)	1.429	0.754	0.016
1	Associate shale gas with lower greenhouse gas emissions (1 = Yes 2 = No)	1.610	0.658	0.018

Scale H = 0.671 (SE = 0.014), N=1218, rho=0.89, alpha=0.88

Table 2. Mokken scale analysis of shale gas issues for respondents who correctly identified shale gas

The relationships among respondents who do not correctly identify shale gas (see Table 3) is radically different to respondents who correctly identify shale gas. Where respondents who answered the qualifier question correctly shows evidence of a very strong unidimensional structure, the analysis of shale gas issue items for respondents who answered incorrectly instead show clear evidence of a two-dimensional structure. The structure within the two scales is also weaker than that seen in Tables 1 and 2. Surprisingly, given earlier research (Howell, 2018), this structure implies that among respondents who did not answer this question correctly there are distinct views about the positives and limitations of shale gas extraction. In effect, among those with lower levels of familiarity with shale gas there is a consistent view about the negatives of shale gas extraction and a structurally distinct view about the benefits of shale gas extraction (coupled with the more neutral question of whether shale gas is associated with lower or higher greenhouse gas emissions). Thus, it is not the case that the least familiar with shale gas extraction have a view that shale gas extraction is either ‘good’ or ‘bad’, but instead that they are potentially open to considering the benefits and limitations of shale gas extraction as distinct issues.

Table 3

Scale number	Variable	Mean	Item *H*	Standard error
1	Associate shale gas with cheap energy (1 = Yes 2 = No)	1.485	0.482	0.052
1	Associate shale gas with clean energy (1 = Yes 2 = No)	1.609	0.552	0.060
1	Associate shale gas with energy security (1 = Yes 2 = No)	1.473	0.438	0.058
1	Associate shale gas with economic benefits (1 = Yes 2 = No)	1.432	0.494	0.062
1	Associate shale gas with lower greenhouse gas emissions (1 = Yes 2 = No)	1.538	0.451	0.059
2	Associate shale gas with Earthquakes (1 = No 2 = Yes)	1.604	0.511	0.081
2	Associate shale gas with contaminated drinking water (1 = No 2 = Yes)	1.580	0.511	0.081

Scale 1: Scale H = 0.482 (SE = 0.047), N=169, rho=0.81, alpha=0.78
Scale 2: Scale H = 0.511 (SE = 0.081), N=169, rho=0.65, alpha=0.65
Table 3. Mokken scale analysis for shale gas issues for respondents who do not identify shale gas

5. Discussion

The analysis shows a strongly unidimensional view of shale gas extraction, for the respondents generally, and for respondents who correctly identify shale gas in the familiarity question in particular. There is evidence of a two-dimensional view of issues relating to shale gas extraction for respondents who do not correctly idenifty shale gas.

The findings have implications of how policies relating to shale gas are presented to the UK public. It is therefore not sufficient for politicians, environmental groups or shale gas developers to address just one facet of the shale gas extraction issue. In particular, this suggests that the government attempts to offset concerns through increasing the perceived economic benefits – including through direct monetary payments to affected areas – is likely to be less effective than they might hope. However, those who are less familiar with shale gas and fracking are structurally different in their opinions, and notably have attitudes reflecting two distinct views. One view relates to negative issues (associating shale gas with earthquakes and contaminated drinking water) associated with shale gas extraction and the other view relates to positive issues (cheap energy, energy security, clean energy, and economic benefits), and the more neutral question about associating shale gas with lower or higher greenhouse gas emissions.

The results of this analysis are significant, not least because they suggest that greater levels of understanding of shale gas are associated with more cohesive views. One potential explanation for this distinction is that greater familiarity with shale gas, including assessments of the benefits and limitations of shale gas exploration, has become a political issue. Indeed, coverage of shale gas in the UK media has bifurcated between a broadly positive view in conservative media, and a negative view in left-liberal media (Jaspal and Nerlich, 2014). It could be that as a result of shale gas being high in levels of public and political attention, and also being controversial across the left/right dimension, political issues are coming to the fore for those people who have more awareness of the issue. Those who fail to recognise shale gas from the list of options available to them may, on the other hand, have been less affected by the politicisation of

shale gas, and so less likely to treat their view of its merits and demerits as a broader political question. In this context, it is interesting to note that a respondent having listed their party ID as Conservative at the 2015 general election (the last general election before this data was collected) is a very significant predictor of a variable capturing the sum total of a respondent's answers on the seven shale gas items we analyse above; but only for those who correctly identified shale gas on the familiarity question. For those who correctly identified shale gas, Conservative Party support produced an increase in positive views of over 30% of the range of the variable and alone explains nearly 17% of the variance of the variable. For those who did not answer the question correctly, Conservative Party support was responsible for a change of less than 12% of the range of the variable and explains approximately 3% of the variance of the variable.

One implication of such dramatic 'information' effects is that it suggests a particularly important role for socialisation in determining how the public approach the issue of shale gas. As such, both shale extraction companies and environmental groups both have very strong incentives to shape the information the public receives towards their overarching political or economic goals. The objective of governments should be to sit as a neutral arbiter between both sides, providing impartial information.

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