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Variation in beliefs about ‘fracking’ between the UK and US

Title: Variation in beliefs about 'fracking' between the UK and US

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Abstract:

In decision-making on the politically-contentious issue of unconventional gas development, the UK Government and European Commission are attempting to learn from the US experience. Although economic, environmental, and health impacts and regulatory contexts have been compared cross-nationally, public perceptions and their antecedents have not. We conducted similar online panel surveys of national samples of UK and US residents simultaneously in September 2014 to compare public perceptions and beliefs affecting such perceptions. The US sample was more likely to associate positive impacts with development (i.e., production of clean energy, cheap energy, and advancing national energy security). The UK sample was more likely to associate negative impacts (i.e., water contamination, higher carbon emissions, and earthquakes). Multivariate analyses reveal divergence cross-nationally in the relationship between beliefs about impacts and support/opposition – especially for beliefs about energy security. People who associated shale gas development with increased energy security in the UK were over three times more likely to support development than people in the US with this same belief. We conclude with implications for policy and communication, discussing communication approaches that could be successful cross-nationally and policy foci to which the UK might need to afford more attention in its continually evolving regulatory environment.

Keywords: shale gas; hydraulic fracturing; cross-national comparison; United Kingdom; United States; energy development

1. Introduction

The general public's framing of unconventional gas development (UGD), portrayed in mass media, social media, and documentary film, has influenced political regulation of

development and the industry's social licence to operate (Lloyd *et al.* 2013, Andrews and McCarthy 2014, Cotton *et al.* 2014, Luke *et al.* 2014, Simonelli 2014, Vasi *et al.* 2015, Williams *et al.* 2017, Bomberg 2015, Mazur 2016). The ability of development to proceed in the UK and elsewhere will depend just as much on public perceptions and acceptability of this form of energy extraction as it does on scientific and technical knowledge (Rayner 2010, Webler and Tuler 2010, The Royal Society 2012, Kasperson and Ram 2013, Stephenson 2016, UKERC 2016). Nevertheless, while research has focused on the extent to which economic, environmental, and health impacts and local contexts associated with extensive development in the US are potentially transferable to the UK (House of Lords 2014, Public Health England 2014), and Europe broadly (EASAC 2014, Pearson *et al.* 2012), similar attention has not been afforded to public perceptions (Thomas *et al.* 2017).

We compare public perceptions of UGD (often called 'fracking')[a] in the United Kingdom (UK) and United States (US) via simultaneously-implemented surveys of representative national samples in both nations. Each nation has witnessed intense mass media coverage (Evensen *et al.* 2014a, Jaspal and Nerlich 2014, Jaspal *et al.* 2014, Williams *et al.* 2017, Ashmoore *et al.* 2016, Bomberg 2015, Mazur 2016), policy attention, and debate on this issue (Small *et al.* 2014, Sovacool 2014, Wiseman 2014, Konschnik and Dayalu 2016). Both nations have considerable unconventional gas reserves in which firms have expressed active interest in exploitation. Many differences exist between the UK and US, however, in: (1) private vs. national ownership of mineral rights, (2) processes for leasing mineral rights, (3) national vs. state/regional/local governance, (4) the level at which most political discourse occurs, and (5) length and depth of experience with physical development (see Stedman *et al.* [2016] for an overview of such differences). Furthermore, the social and

[a] Note: We use the term 'unconventional gas development' throughout this article to refer to the set of processes and associated effects that attend this form of energy extraction/development. While no term is perfect, social-psychological research into how this word is used provides nuanced discussions of why to avoid use of 'fracking' (Wolske and Hoffman 2013, Evensen *et al.* 2014b, Evensen 2016). We employ this term to mean the processes most commonly linked to 'shale gas' and 'fracking' in public and mass media discourse

cultural contexts vary considerably across nations (Partridge *et al.* 2017). The differences in policy and regulation between the US and Europe on UGD (Boersma and Johnson 2012, Wang and Hefley 2016, Whitton *et al.* 2017) and the differential influence of communication on policy across these regions (Metze and Dodge 2016, Bomberg 2017, Dodge and Metze 2017) have been a topic of notable academic interest. Far less research has compared public perspectives on UGD.

Public perceptions on this issue have been studied extensively in the US (e.g., Anderson and Theodori 2009, Braiser *et al.* 2011, Perry 2012, Jacquet and Stedman 2013, Kriesky *et al.* 2013, Ladd 2013, Theodori 2013, Jacquet and Stedman 2014, Theodori *et al.* 2014, Clarke *et al.* 2015, Crowe *et al.* 2015, Evensen 2015, Evensen *et al.* 2017, Israel *et al.* 2015, Morrone *et al.* 2015, Schafft and Biddle 2015, Sangaramoorthy *et al.* 2016, Kroepsch 2016; see Thomas *et al.* 2017 for a review) and UK individually (e.g., Cotton *et al.* 2014, Cotton 2015, Whitmarsh *et al.* 2015, Williams *et al.* 2017, Bomberg 2015, Andersson-Hudson *et al.* 2016, O'Hara *et al.* 2016; see Lis *et al.* 2015 for a review), but to our knowledge there has been no cross-national quantitative comparison of factors influencing perceptions. One study has compared perceptions across in-depth qualitative workshops in select cities within the UK and California (Partridge *et al.* 2017). Other research compared perceptions across in-depth individual interviews: (1) in the US and Canada (Evensen and Stedman 2017a) and (2) nations in Eastern Europe (Goldthau and LaBelle 2016, Goldthau and Sovacool 2016). Furthermore, we previously reported on different data from the same comparative surveys examined herein to explore the relationship between awareness of UGD and support for development cross-nationally (Stedman *et al.* 2016). In this article, we substantially further understanding of cross-national differences by examining UK versus US differences in associations between beliefs about impacts caused by UGD and support for UGD. This new analysis allows us to consider why cross-national variations exist; we then

use this information to recommend how political communication and policy approaches in each nation could mirror or depart from those in the other nation.

1.1. Research questions

The differences between the UK and US and the interest in identifying lessons from the US experience with UGD that could apply in the UK, led us to the following research questions that guided our data collection and analysis:

1. What differences, if any, exist between the UK and US on beliefs about impacts associated with UGD?
2. Are cross-national differences in support and opposition unique to UGD or are they also reflected in support for and opposition to other energy sources?
3. What factors (e.g., beliefs and/or demographic characteristics) exert the greatest influence on support for and opposition to UGD in each nation? Do these factors, or the strength of their relationship with support and opposition differ cross-nationally?

2. Methods

We used an existing, repeated cross-sectional online survey of the UK general public to conduct a UK/US comparison of public perceptions. We implemented nearly identical surveys with the UK sample (7-9 September 2014, n=3823, administered by YouGov) and US sample (16-19 September 2014, n=1625, administered by Qualtrics). Both surveys approximated their respective national populations with respect to sex, regional distribution (by state in the US and by the 12 national census regions in the UK), and age (of individuals 18 years and older).[b] Because both survey firms draw respondents from online panels, quotas

[b] Note: The US sample oversampled residents from PA (N=254) and NY (N=262) to allow for cross state comparisons of these two states in the Marcellus Shale region with different regulatory climates on UGD. For all analysis in this article, unless specified otherwise, we applied proportional weights to the NY and PA sub-samples to constrain these to represent the proportions of the national population from NY and PA.

were applied to responses to ensure that the resulting responses match the national averages demographically. In addition to the aforementioned metrics on which the samples were representative, the YouGov sample also used quotas for social class (a UK marketing research metric) and type of newspaper readership.

While the two surveys employed mostly the same questions, wording did vary in a few instances (see supplemental methods material). An additional limitation is the slightly different recruitment strategies of the online firms that conducted the research in the respective nations, although both did employ existing online panels and used quota sampling approaches. Furthermore, the samples were nationally representative based on population distribution across the nations, meaning that areas with low population have very little representation in the surveys (e.g., states such as the Dakotas, Wyoming, and Montana; regions such as Scotland, Wales, and North East England; and all rural areas). This means that areas with UGD (or potential for UGD) contributed few respondents. The goal, however, was not a cross-state comparison within the US or a cross-region comparison in the UK; instead we sought to identify macro-level differences between the US and UK. 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 (see Clarke *et al.* [2016] and Evensen and Stedman [2016] for a discussion of differences in perception based on scale of analysis).

The original wording appears in our supplemental material for each question we report on in the results section. These were not the only questions in the survey (for the full survey text also see the Supplemental Information). We began the survey with a question asking respondents to identify which gas, from a list, is associated with hydraulic fracturing or 'fracking'. If they answered correctly ('shale gas'), they continued on to the rest of the

survey; if they answered incorrectly, they received a brief statement about shale gas and then continued.

3. Results

3.1. UK/US differences in support and opposition

In our previous analysis of this data set (Stedman *et al.* 2016), we report on basic descriptive statistics – herein we focus on multivariate relationships. The prior analysis revealed that 60 percent of the US sample replied shale gas extraction 'should' be allowed, whereas 25 percent answered 'should not', and 16 percent responded 'don't know'. In the UK sample, 44 percent responded 'should', 27 percent answered 'should not', and 29 percent responded 'don't know'. Uncertainty was almost twice as prevalent in the UK as in the US, despite twice as many people in the UK answering the awareness question correctly as in the US (72% versus 36% - which gas, from a list, is associated with hydraulic fracturing?). In addition to the national level analysis on support and opposition, we compared across areas within each nation (see supplemental information for these data).

Below we address each of our research questions in turn, and in doing so shed light on possible rationales for cross-national differences in support and opposition.

3.2. UK/US differences in beliefs about impacts

We asked respondents whether or not they associated six distinct impacts with shale gas (Figure 1; see also Table 1 in Supplemental Information for the full data). When excluding 'don't know' answers, a higher percentage of UK respondents, compared with US respondents, associated the three negative impacts with shale gas (i.e., earthquakes, water contamination, and higher emissions); a higher percentage of US respondents associated the three positive impacts with shale gas (i.e., cheap energy, clean energy, energy security).

The largest differences between nations were for clean energy (43 percent in the US vs. 25 percent in the UK associated it with shale gas) and cheap energy (55 percent in the US vs. 43 percent in the UK). The percentage of 'don't know' responses was high in both nations (over 25 percent for all six associations) and particularly for association with higher vs. lower greenhouse gas emissions (over 40 percent in each nation). This mirrors scientific

uncertainty and disagreement over whether UGD will increase or decrease net carbon emissions (Alvarez *et al.* 2012, Newell and Raimi 2014).

3.3. Support for other energy sources

Our second research question queried the broader context around the cross-national differences observed in relation to UGD – are these reflected in support for and opposition to other energy sources? We asked whether respondents supported or opposed domestic production and use of each of eight renewable energy, fossil fuel, and nuclear energy sources. For the comparisons below, we include respondents who answered the question affirmatively or negatively (i.e., excluding 'don't know' and 'neither support nor oppose' responses to allow for comparison of the differently-worded questions across the two samples; all responses are reflected in Table 2 in the Supplemental Information, however). Statistically significant differences, via independent samples t-tests, existed between nations for seven of the eight energy sources (Figure 2). Support was higher in the US for five sources. Nevertheless, high support for all forms of renewable energy listed (i.e., solar, hydro-electric, wind, and bioenergy) *and* for conventional natural gas existed in both nations. More than 92 percent of US respondents with positive or negative views on the energy source in question supported use of each of these five energy sources, while at least 83 percent in the UK supported use of each source.

Of respondents who supported or opposed development (not answering 'don't know' [UK survey] or 'neither support nor oppose' [US survey]), support for shale gas as a future national energy source was higher in the US (68 percent) than in the UK (58 percent). In each case, the percentage of respondents supporting shale gas for domestic use was substantially lower than the percentage supporting conventional natural gas (93 percent in US; 83 percent in UK). Support for the other fossil fuel, coal, was higher than support for

shale gas in the UK; the opposite was true in the US sample (again, excluding 'don't know' and 'neither' responses). Compared to other energy sources, support for nuclear power was by far the lowest in the US (45 percent). Although support was not high in the UK (66 percent), the gap between nations was largest for this energy source.

3.4. Factors affecting support for UGD; cross-national differences

We ran binary logistic regressions for each nation to examine the effect of people's beliefs about potential impacts, and a range of socio-demographic attributes, on their support for / opposition to UGD ('don't know' responses were excluded from this analysis) (Table 3). We originally included additional descriptive variables in the regressions (i.e., education level, household income, political affiliation), but because these variables were non-significant in each regression, and they reduced the effective sample size by more than half in the UK sample (due to non-response on some of the variables), we removed them from the final analysis. We also included awareness of shale gas development, but again this was unimportant in the regressions and we removed it (see supplemental information for details).

While the Nagelkerke pseudo-R^2 values (Nagelkerke 1991) for both nations' models were quite high, the UK R^2 (i.e., percent variation in the dependent variable explained by the set of independent variables) was substantially higher (0.75 for UK; 0.54 for US). Much research on public perceptions of UGD in the US has asserted that beliefs about impacts are key correlates of support/opposition (Jacquet and Stedman 2013, Theodori 2013, Evensen and Stedman 2017b); our data suggest that this is true to an even greater extent in the UK.

All odds ratios for the associations were in the intuitive directions – beliefs that risks exist were associated with opposition; beliefs that benefits exist were associated with support. Beliefs that water contamination, higher greenhouse gas emissions, and earthquakes will occur link with more opposition. In contrast, if one associates development with cheap

energy, clean energy, or energy security, one is more likely to support development. The degree to which beliefs about cheap energy, water contamination, and higher greenhouse gas emissions are associated with support for UGD is remarkably similar across the nations (as measured by the odds ratios).

A substantial cross-national difference emerges in the extent to which association with energy security correlates with support; UK respondents who associated UGD with energy security were 8.3 times more likely to support development than UK respondents who did not make this association (the odds ratio in the US was only 2.3). A logistic regression for the UK sample with support/opposition as the dependent variable and association with energy security as the sole independent variable generated a Nagelkerke pseudo-R^2 of 0.52, meaning that this association alone could explain over half of the variation in support for and opposition to development.

4. Discussion and communication implications

Shale gas received the least support in the UK of any of the eight energy sources considered in our survey. Even coal, widely recognised as more polluting, more detrimental for climate change, and more liable to cause human health problems (Duggan-Haas *et al.* 2013), received greater support. This could owe, in part, to the UK having much more historical experience with coal extraction than with onshore gas development – coal is a known entity (Gunzburger *et al.* 2017). Nevertheless, support for shale gas contributing to the future energy mix in both nations outstripped opposition, and more respondents in both nations supported domestic production and use than opposed it.

In both nations, the opposition that exists to UGD seems to have little to do with the *gas* aspect, as support for conventional natural gas use parallels levels for renewable energy sources. This has considerable implications for communication and policy on this issue,

especially in light of the UK government's announcement in November 2015 – and renewed commitment under Prime Minister Theresa May's current Government – of bringing more gas-fired electricity generating plants online to replace coal-fired plants – all of which are slated to be retired by 2025. Focusing on differences (or lack thereof) between unconventional and conventional development in mass media and political discourse could strongly shape policy conversations and public perceptions. The UK Government, industry, and other entities supporting UGD would likely see this as an opportunity to highlight similarities between UGD and conventional development (e.g., that which has occurred in the North Sea for decades), while opponents such as community 'frack free' organisations and environmental non-governmental organisations would seek to emphasise the differences. Our recommendation is that any party interested in fostering informed decision-making clearly explicate, in accessible language, the similarities and differences between conventional and unconventional development in terms of both the techniques employed and the potential impacts on environment, economy, and social life.

The cross-national differences in beliefs about impacts highlight that the 'cheap and clean' depiction of UGD conveyed in the States has clearly not been accepted to the same extent in the UK. Discourse and mass media coverage on UGD in the States is decentralised and regional, varying from state to state (Ashmoore *et al.* 2016), whereas national media coverage is the primary means of information sharing in the UK (Bomberg 2015; Cotton 2015, Williams *et al.* 2017). Coverage that challenges the 'cheap and clean' message would thus be more diffuse in the US and any exposure to this message likely would not be evident in a national sample survey that has little representation of individuals living in the rural areas where development occurs or is likely to occur (i.e., where regional mass media coverage on this topic is based). Conversely, the natural gas industry has engaged in extensive television advertising in the US, employing the rhetoric of 'cheap and clean'. Indeed, previous research

has found an association between obtaining information predominantly from television and increased support for UGD (Boudet *et al.* 2014).

The results herein help explain our previously-reported finding that support is substantially elevated in the US sample compared to the UK sample (Stedman *et al.* 2016). The effect sizes of the binary logistic regressions showed that a large percentage of the variance in support and opposition can be explained by beliefs about a relatively small number of impacts potentially associated with UGD (six beliefs explain 54% of variance in the US and 75% in the UK). When excluding 'don't know' responses, the UK sample perceived, on average, all three negative impacts to be more likely than the US sample did. Conversely, the US sample perceived all three positive impacts as more likely than the UK sample did. If we assume that beliefs about impacts precede evaluations of support and opposition, the cross-national differences in beliefs about these six impacts can explain the majority of the difference in support and opposition cross-nationally.

The substantial percentage of 'don't know' responses to the support/opposition question and to the six 'beliefs about impacts' questions reveals that there might be a large undecided population whose views on this topic can be shaped further. Recent research has shown that additional information about impacts of UGD can influentially shape overall attitudes and beliefs (Whitmarsh *et al.* 2015). Beliefs about UGD's effects on water contamination, energy security, and carbon emissions are all strongly associated with likelihood of support for UGD; furthermore, over 30 percent of respondents in each nation answered 'don't know' as to whether these effects were associated with UGD or not. Due to the important connection between beliefs about these issues and support/opposition, and the amount of indecision about UGD especially in the UK, communication about these effects could potentially influence public perceptions to a heightened extent in the UK compared to the US.

5. Policy relevance

In this section, we focus predominantly on policy in the UK, because the UK Government is currently seeking to move forward with shale gas extraction (in England), the Scottish Government is consulting on what approach to take to shale gas regulation in Scotland, and both are trying to learn from US experience for the formation of policy. The Scottish Government (2017) is examining whether to lift its moratorium on UGD and Her Majesty's Treasury (2016) is reviewing evidence from a consultation on how to approach setting up a Shale Wealth Fund to compensate people in England living near shale developments. In both instances, information is being drawn from the US experience. We are not aware of any examples of US states or US regulatory authorities looking to the UK experience to inform their policy and regulation. This does not mean that policy developments in the States are not important or interesting; we simply feel that UK policy has much more to learn from a comparison of UK and US perceptions than US policy has to gain from such a comparison. The fact that regulation is much less decentralised in the UK also means that policy directions can be discussed more clearly and concisely in that nation (i.e., only the four national governments – England, Scotland, Wales, and Northern Ireland – have jurisdiction over regulation).

In Her Majesty's Treasury's (2016) recent consultation on a proposed shale wealth fund, the UK Government revealed it wants to make benefits of shale gas development to local communities more tangible. While this is certainly one approach to increasing support for shale gas development (the Government's clear goal), the importance of national-level implications of development (e.g., energy security and carbon emissions) cannot be neglected. Likewise, our finding that the public attribute as much importance to beliefs about water contamination in the UK as do the public in the US (where this is often reported as the

central issue affecting support/opposition), reveals that UK Government discourse and regulation must not dwell solely on benefits, but also on proper management and regulation of risks.

Water contamination due to UGD in the US is not common, and most of the water contamination that has occurred has been due to surface spills, although some has arisen through cement well casings that have failed (Rahm and Riha 2012, Olmstead *et al.* 2013, Vidic *et al.* 2013, Stokstad 2014, Vengosh *et al.* 2014, Llewellyn *et al.* 2015). Therefore, regulation that is designed to prevent and remediate surface spills and that ensures the best possible well casing standards (which vary widely across US state's regulations) would benefit the UK. The presence and promotion of best practices in the UK will not necessarily assuage concerns related to water quality, but this clearly an area of concern as in the US, and explicit focus in regulation and Government discussion of the topic is necessary to respond to public concerns. In this respect, the British Geological Survey's baseline monitoring of water quality at all sites with UGD wells sited is a good first step.

In terms of communication from interest groups opposed to the Government's current support for development, these entities (e.g., Friends of the Earth and 'Frack Free' organisations within communities throughout the UK) have already focused on water contamination, earthquakes, and their questioning of the premise that shale gas development benefits carbon emissions – due to incentivising investment in further infrastructure that will prolong dependence on fossil fuels. Our finding on the importance of beliefs about energy security intimates that these groups also could benefit from an explicit focus on the energy security implications of UGD. For example, if UGD is to be opposed, what other energy sources can be realistically relied upon to enhance the energy security that clearly matters to the British public?

In terms of the effect of associating UGD with higher carbon emissions on support/opposition, Whitmarsh and colleagues (2015) have independently shown through an embedded experiment in a survey of UK residents that providing people with additional information about the connection between UGD and carbon emissions can change attitudes, particularly for individuals without firmly held views on whether such a relationship exists. Considering that 42% of survey respondents in the US and 49% of respondents in the UK reported that they 'don't know' whether UGD is associated with higher carbon emissions or not, this could be a fruitful area for further communication in either nation. While much research has established the connection between views on climate change and political leaning (i.e., liberals are more likely to attribute climate change to anthropogenic sources and to be concerned about it compared to conservatives), no research yet has examined whether political views affect the extent to which an association is made between climate change and UGD. One might hypothesise that liberals would associate higher emissions with UGD, while conservatives would associate lower emissions with UGD; this remains an important area for further inquiry. Nevertheless, the fact that nearly half of all respondents in both surveys were undecided on this association indicates that, unlike views on climate change itself, views on this association between emissions and UGD might be susceptible to influence through provision of additional information.

The largest difference between nations, in terms of factors affecting support and opposition, is the magnitude of influence that beliefs about energy security exerts upon support for UGD. Whether one associates development with water contamination was the leading correlate of (lack of) support for UGD in the US; energy security was the strongest correlate of support for UGD in the UK. Conversations about energy security do exist in the US (often framed as 'energy independence'), but are likely more salient in the UK. This difference in salience is because the US expects to be a net natural gas exporter by 2017 (US

EIA 2016), while in 2014, imports represented over 60 percent of total natural gas supply in the UK (UK Government 2015). Energy security is also a prominent topic in the UK due to: (1) concerns over the UK's declining domestic oil and gas reserves in the North Sea, (2) the Government's proposed closure of all coal-fired power plants by 2025 (ostensibly necessitating more power generation from natural gas), and (3) concerns about importing gas originally sourced from Russia (a politically unstable trade partner, as evidenced by Gazprom's dealings with Ukraine; Russia supplies Europe with about 30% of its natural gas). In contrast, the US sources 97% of its imported natural gas from Canada (US EIA 2015). This importance of contextual factors in shaping widely varied views on energy security cross-national has been highlighted previously (Sovacool and Vivoda 2012, Knox-Hayes *et al.* 2013, Sovacool 2016), as has the high level of concern about energy security in the UK specifically (Demski *et al.* 2014).

Energy security is mentioned frequently in UK mass media and policy discourse (UKERC 2016) and Prime Minister Theresa May and former Prime Minister David Cameron have championed energy security as a rationale for pursuing UGD. Thirty-five percent of the UK respondents 'don't know' whether they would associate energy security with UGD or not; their ultimate determination on that question could substantially influence whether or not they support the UK engaging in substantial commercial scale UGD. The implications of this fact for communication are clear for individuals on all 'sides' of this issue. Arguments about the ways in which, and extent to which, domestic unconventional gas can forward energy security (or not) could prove pivotal for decreasing equivocation and indecision on attitudes towards UGD in the UK. The magnitude of the difference in association between energy security and support for development between the US and UK certainly justifies more inquiry on this relationship. In such future inquiry, numerous operationalisations of the multi-faceted

concept of 'energy security' (Sovacool *et al.* 2012) would increase understanding of what exactly motivates the connection between the variables.

6. Conclusions

The findings presented herein highlight the similarities and differences in perceptions of energy development that can emerge across differing cultural, governance, and geopolitical contexts. Despite contextual differences, several commonalities were manifest cross-nationally. Communications designed to target wide-ranging audiences on this topic could focus on those commonalities. Even within the US, there is considerable variation in regulation, mineral rights ownership, and discourse across states, making this recommendation equally applicable intra-nationally within the US. The cross-national differences reported herein afford government, non-governmental organisations, and industry the opportunity to target messages about specific impacts and characteristics of UGD to nationally- or regionally-specific audiences.

Finally, the notable differences between perceptions of UGD in UK versus the US, as well as the similarities, reveal the need for better understanding of public perceptions in multiple nations debating UGD. Such perceptions directly affect the industry's social licence to operate (Lloyd *et al.* 2013, Luke *et al.* 2014, Gunzburger *et al.* 2017, Bradshaw and Waite 2017). A dearth of social scientific information exists about UGD cross-nationally, even in many industrialised nations in Europe (Lis *et al.* 2015) and in Canada (Thomas *et al.* 2017). Most understanding is limited to findings from the United States, with some attention to the United Kingdom, and less to Canada, the Netherlands, Australia, and sparse studies in other western nations (e.g., Poland, France [Gunzburger *et al.* 2017, Lis and Stankiewicz 2017, Lis and Stasik 2017]).

The knowledge gap is even more noticeable in developing nations (e.g., Argentina, Mexico, China, South Africa) considering or moving forward with UGD, where no empirical findings on public perceptions of unconventional gas development whatsoever have entered the peer-reviewed research literature. Our findings of cross-national commonalities suggest that some context-specific data from the US might apply to these foreign situations (e.g., in relation to beliefs about water contamination and/or carbon emissions), but other US findings will be of little use for understanding perspectives in those nations. One could easily predict substantial cultural differences between, for example, developing nations and the US – which could shape public perceptions. This discussion highlights the dangers of generalising across national contexts, and makes the case for increased understanding in nations where we know little to nothing. This is perhaps the single greatest current research need in relation to public perceptions of UGD.

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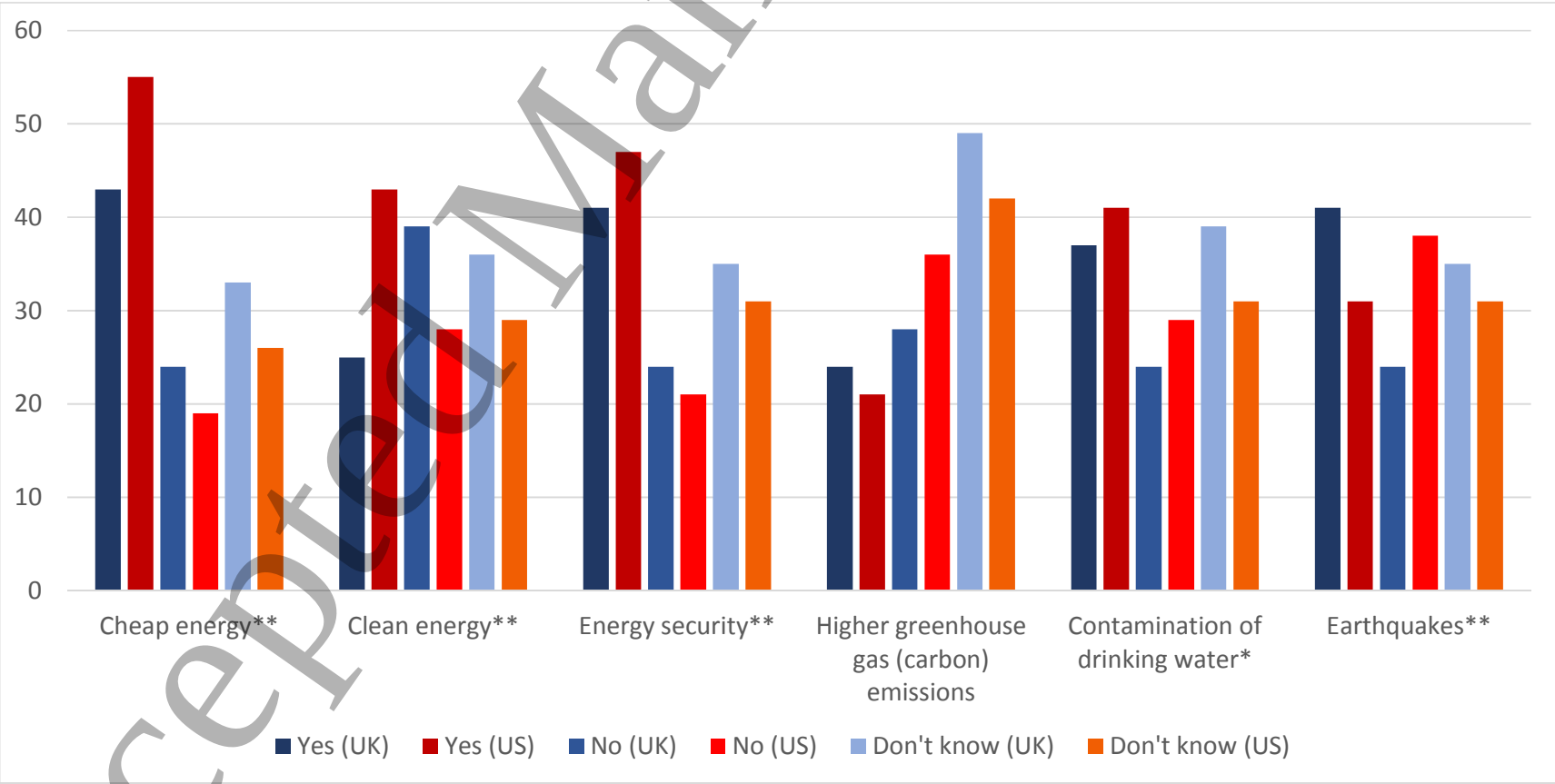
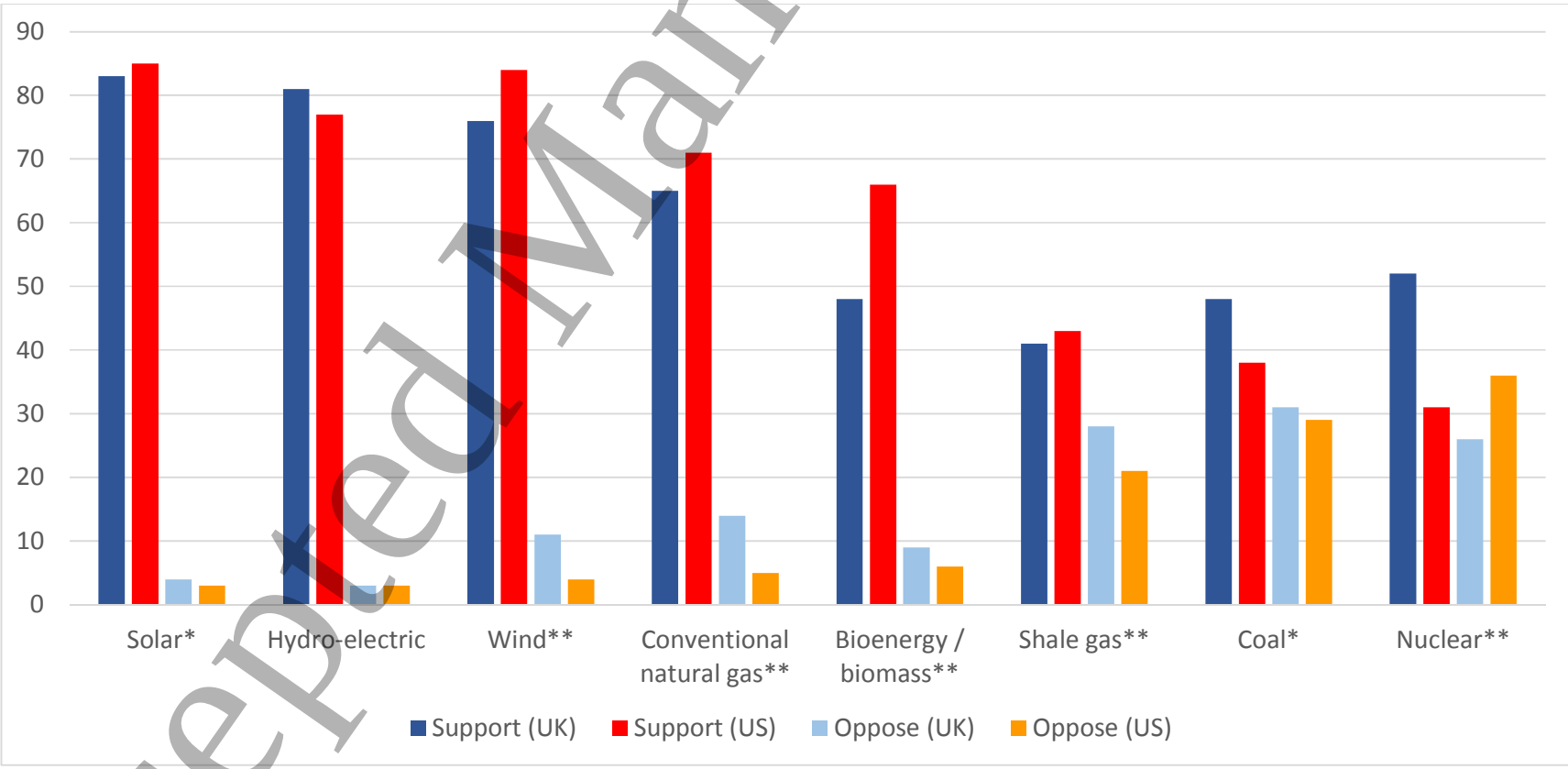
Figure 1: Do you associate the following with shale gas?



* independent samples t-test between nations significant at $p < 0.01$; ** significant at $p < 0.001$. T-test excludes 'don't know' responses from the analysis.

Figure 2: Support for domestic use of various energy sources



* independent samples t-test between nations significant at $p < 0.01$; ** significant at $p < 0.001$; t-test compares the UK response option 'should be part of the UK's energy mix' to the US response options 'support' and 'strongly support' (pooled together); UK response option 'should NOT be part of the UK's energy mix' is compared to 'oppose' and 'strongly oppose' (pooled)
NB: 'don't know' and 'neither support nor oppose' responses are not included for significance tests to allow for comparability across samples

Table 3: Binary logistic regression, support/opposition and associations with shale gas

	United States (N = 546)			**United Kingdom** (N = 1130)		
	Odds ratio	Sig.	Standard error	Odds ratio	Sig.	Standard error
Associated with…						
Earthquakes	**0.40**	.000	0.26	**0.28**	.000	0.26
Cheap energy	**2.16**	.005	0.27	**2.18**	.001	0.23
Water contamination	**0.20**	.000	0.32	**0.20**	.000	0.28
Clean energy	**2.16**	.010	0.30	**2.94**	.000	0.30
Energy security	**2.25**	.004	0.28	**8.27**	.000	0.24
Higher GHG emissions	**0.31**	.000	0.26	**0.30**	.000	0.26
Socio-demographic attributes						
Sex (0=male; 1=female)	0.64	.084	0.26	**0.61**	.026	0.22
Age	1.00	.581	0.00	1.00	.634	0.01

Nagelkerke R^2: 0.54 (United States) 0.75 (United Kingdom)
Cox and Snell R^2: 0.38 (United States) 0.56 (United Kingdom)

NB: The dependent variable is coded as 1=extracting natural gas from shale in [UK or US] should be allowed, 0=should NOT be allowed; **bold** odds ratios denote significant parameter estimates ($p < 0.05$).