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Public perceptions of hydraulic fracturing (Fracking) in Canada: Economic nationalism, issue familiarity, and cultural bias

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ABSTRACT

New applications of hydraulic fracturing (HF) methods to release natural gas from shale deposits have emerged as a hotly contested political issue. Consequently, researchers commonly seek to identify factors shaping public perceptions of this technology. While research conducted in North America has focused primarily on the United States, this paper contributes to a growing body of work examining Canadian perceptions toward HF. We build on the existing regionally-focused literature on public perceptions of HF in Canada with an analysis of data collected from a nationally-representative (n = 2012) survey of attitudes toward hydraulic fracturing administered to the adult Canadian population in 2016. We find that an individual's cultural biases are strong predictors of their attitudes toward hydraulic fracturing, and that these effects are moderated by levels of issue familiarity. Analysis of an embedded survey experiment further reveals that attitudes in Canada are somewhat affected by cues regarding the developer's status (i.e. whether a Canadian, American or government-owned corporation), and that a nationalist bias is especially prominent among people with hierarchical predispositions. We further find that familiarity with hydraulic fracturing is associated with significantly less support, and that this relationship is moderated by a respondent's region of residence. We discuss these findings in light of the existing literature and outline areas for future research.

1. Introduction

For decades, Canada has been one of the world's largest producers of energy, including natural gas (Natural Resources Canada, 2017). The expanded use of horizontal and directional drilling, combined with hydraulic fracturing (HF) or "fracking[1]," has further cemented Canada's status as a leading natural gas producer and exporter. Following a decades-long decline in conventional production, shale and tight gas production has more than doubled, resulting in a reversal in fortunes as the country has quickly replaced its plans for building liquefied natural gas (LNG) *import* terminals, to building LNG terminals to *export* Canada's gas to other regions of the world (Mousseau, 2010). By 2035, unconventional gas development is expected to account for roughly 80 percent of Canada's total production of marketable natural gas (National Energy Board, 2015, 2017). While these developments place Canada at the forefront of global unconventional gas production (Maugeri, 2013), however, they have also generated considerable public controversy across parts of the country. Key fault lines in this debate relate to the economic promise of jobs, enhanced export opportunities, cheap and abundant natural gas vs. the local (air and water) and global (climate) environmental effects, unequal distribution of risks and rewards, and the rights of First Nations and local communities to decide what constitutes acceptable and unacceptable risk. As a result of these debates, use of hydraulic fracturing has become a hotly contested political issue across parts of Canada.

A number of developments point to the heightened level of public controversy around natural gas production in Canada. This includes the mobilization of citizen groups and public demonstrations against hydraulic fracturing, particularly in Quebec and New Brunswick (Bherer et al., 2013). Opposition is also evident in places where natural gas development is most intense, such as in British Columbia, where controversy over the development of unconventional hydrocarbons is now part of intense debate over whether or not to move forward with the building of new oil pipelines and LNG export terminals (Bennett, 2017). In jurisdictions traditionally less involved with the oil and gas sector, public opposition has played a more direct role, leading the provinces of Quebec, New Brunswick and Nova Scotia to enact *de facto* moratoria on fracking. In each of these cases, government officials have explicitly

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[1] To avoid repetition, we use the terms hydraulic fracturing, HF and "fracking" interchangeably throughout the text.

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cited the need for a social license – in addition to a clearer understanding of benefits and risks – as conditions that must be met before lifting the moratoria (CBC, 2014; Canadian Press, 2018; Presse Canadienne, 2016). Reflecting the heightened salience of hydraulic fracturing in various parts of the country, several studies examine the considerable amount of media attention garnered so far, which varies substantially in tone from one region to the next (Montpetit et al., 2016; Olive, 2016).

Several public opinion polls conducted in Canada further point to substantial levels of public opposition (Lachapelle and Montpetit, 2014). In 2012, a Léger poll conducted on behalf of the oil and gas services industry in Quebec found less than 20% of the population are supportive of developing shale gas in the province (Presse Canadienne, 2012) while a Corporate Research Associates poll found a slight majority of Nova Scotia residents oppose hydraulic fracturing (Corporate Research Associates, 2013). More recently, polling in British Columbia finds less than 25% of respondents support fracking, despite (or because of) the fact that the province has seen the most intensive use of hydraulic fracturing in all of Canada (Insights West, 2016). Meanwhile, polling at the national level has found that Canadians are sharply divided on whether or not to allow hydraulic fracturing, with 50% of Canadians agreeing that fracking activities should be suspended until risks are better understood (Campbell and Lewis, 2012). While these polls are helpful in terms of gauging public attitudes toward hydraulic fracturing in Canada, we still lack a clear picture of what structures public opinion on this question at the national level, and the extent to which these attitudes are amenable to change.

Given the importance granted by political leaders in Canada to public opinion on hydraulic fracturing, and in light of the relative dearth of empirical work in this area, understanding the structure of public attitudes toward hydraulic fracturing in Canada appears central to understanding past and future government decisions on whether or not to allow, and if so, how to regulate its use within their jurisdictions. In this context, the following provides the first systematic assessment of some of the drivers of Canadian attitudes toward hydraulic fracturing at the national level. We begin with a brief review of the Canadian case, including a review of the literature on public opinion and media coverage of hydraulic fracturing in Canada. Next, we outline our research questions and methods before presenting results. We conclude with a discussion of our results in light of the existing literature, and highlight implications for future research.

2. Background

Canada is among the world's most important producers of energy, ranking second in the production of uranium, fourth in crude oil, fifth in natural gas, and twelfth in the production of coal (Natural Resources Canada, 2017). A net energy exporter, Canada's energy sector (including the entire supply chain) contributed over 10% to gross domestic product, while directly or indirectly employing over one million Canadians, or 5% of total employment, in 2015. In some Canadian regions (notably in Saskatchewan and Alberta), the energy industry plays a decisive economic role, accounting for about one fifth of provincial GDP and providing provincial governments with at least one fifth of their total revenue between 2010 and 2015 (CBC, 2016; Natural Resources Canada, 2017). The country is also home to abundant resources of natural gas. Of the estimated 30.8 trillion cubic metres of natural gas remaining in the country, about 72% is found in tight and shale gas formations in Alberta and British Columbia (National Energy Board, 2017), though substantial deposits have been found in parts of Eastern Canada (notably Quebec and the Atlantic region) as well. To date, development of these resources is concentrated in the Montney Play (straddling British-Columbia and Alberta), the Horn River Basin in British Columbia, the Duvernay Formation in western Alberta, and the Colorado Group that stretches from western Alberta to Saskatchewan (Rivard et al., 2014). Such variation in the distribution and production of unconventional gas has created very different political dynamics surrounding this issue in Canada.

Characterized by an abundance in shale gas resources, the Canadian experience provides a useful case for examining the political dynamics surrounding hydraulic fracturing outside the United States. As is the case in the U.S., the Canadian federation is highly decentralized, empowering provincial governments with significant jurisdictional autonomy. This autonomy has contributed to important differences in the way provinces have chosen to manage their resources, which vary substantially from one jurisdiction to the next. In the western provinces, governments have welcomed technological innovations to help enhance oil and gas recovery, while eastern provinces have so far been much more restrictive in terms of allowing hydraulic fracturing on their territory (Montpetit et al., 2016). Such wide-ranging regional specificities provide considerable leverage for examining the importance of context in shaping public opinion. Moreover, unlike the United States, which grants subterranean mineral rights to the owner of the surface land, Canada's natural resources are owned by provincial governments. This creates very different incentives for property owners, and makes the Canadian case more comparable to other jurisdictions with this more common, publically owned, mineral rights regime.

In recent decades, technological advances in horizontal and directional drilling, combined with hydraulic fracturing, have led to the extensive development of Canada's unconventional gas (tight and shale) resources. To release gas from shale, a mix of water, sand and chemicals are pumped at high pressure deep underground, creating fissures in the geological formations in order to recover the trapped oil and gas. Since first applied in Alberta in the 1950s, over 170,000 oil and gas wells have been fractured, oftentimes by American corporations that have pioneered the technology in the United States (Ewart, 2014). The application of HF by mostly foreign corporations has raised a number of concerns in Canada. Many of these concerns centre on issues around potential environmental impacts, prompting Environment Canada to commission a study in 2014, which concluded that the science is largely unsettled and more research is needed to better determine the risks posed by fracking for groundwater, methane leaks, seismic activity, and human health (Council of Canadian Academies, 2014). Additional debate also surrounds the relationship between unconventional gas development via hydraulic fracturing, and greenhouse gas emissions (GHG), particularly in British Columbia, where GHG emissions are often cited as a reason to oppose the industry (Bennett, 2017). However, research conducted in the United States has found that perceived local impacts explain more of the variation in levels of support and opposition than do perceptions about the impacts of hydraulic fracturing for global climate change (Evensen and Brown-Steiner, 2017).

In addition to the environmental risks associated with hydraulic fracturing, other groups in Canada have raised concerns around the distribution of benefits and risks from fracking, as well as the relative rights of host communities vs. those of multinational corporations. In its evaluation of the potential economic impacts of fracking for the province, the *Bureau d'audiences publiques en environnement* (BAPE) – a provincial government agency dedicated to public information and consultation on matters related to energy and environment in Quebec – took issue with the "fly-in-fly-out" practice common in the oil and gas industry (BAPE, 2014: 336). This concern that (foreign) corporations stand to benefit more than host communities was also commonly found in media portrayals of fracking in Quebec (Montpetit et al., 2016), and is commonly found in other jurisdictions as well (Borick et al., 2014). Other concerns have been raised regarding the legitimacy of corporate lawsuits under NAFTA's chapter 11 taken against local and regional governments that have banned fracking in Canada (Gray, 2012). These issues point to a broader set of considerations that are relevant in the debate over hydraulic fracturing in Canada.

In light of these myriad concerns, obtaining a "social license" to frack in Canada is far from straightforward. Yet the literature on public perceptions of hydraulic fracturing lags significantly behind research in

other parts of the world, notably the U.S. and U.K. For instance, in their review of the literature, Thomas and colleagues (2017) found just four studies focused exclusively on Canadian public opinion on hydraulic fracturing, and an additional three comparing public perceptions across Canada and the United States, out of 58 articles examined. A further search of *Google Scholar, Web of Science,* and the *Worldwide Political Science Abstracts* further suggests that a national level study of public opinion on fracking in Canada has yet to be published in the academic literature. Findings from the existing, regionally-focused literature show wide variation in levels of support for hydraulic fracturing across provinces (O'Connor and Fredericks, 2018; Lerner, 2014). Existing research is also mixed, with some showing relatively strong support for hydraulic fracturing in New Brunswick (O'Connor and Fredericks, 2018) and others finding contradictory results when looking specifically at a particular county in the same province (Fast and Nourallah, 2018). These results beg the question of generalizability, and raise the question of whether or not, and the extent to which, results from the existing literature are conditioned by context.

2.1. Objectives

The primary objective of this paper is to identify the drivers of public attitudes toward HF (i.e. levels of support and opposition). It also assesses the malleability of Canadian public opinion by exploring the possibility that attitudes are conditioned by a nationalist bias in favour of (against) national (foreign) corporations. Specifically, the paper addresses three questions. What drives support and opposition toward hydraulic fracturing in Canada? Is there a nationalist bias in terms of to the public's willingness to grant a social license to frack? To what extent are these effects conditioned by individual cultural biases and region of residence?

2.2. Literature review

As is the case for other new technologies, a number of studies suggest that differences in attitudes toward hydraulic fracturing are fundamentally related to conflicting public values and worldviews. This literature draws heavily from the cultural theory of risk (Douglas and Wildavsky, 1982; Thompson et al., 1990), and suggests that public perceptions of risks and hazards are filtered through people's cultural 'way of life,' which consists of a viable combination of social organization (i.e. patterns of social relations) and cultural biases (i.e. shared values and beliefs).[2] From this perspective, public controversies over new technologies "…represent more fundamental debate about the social and political meanings of technologies and their implications for alternative ways of life" (Dake, 1992). To the extent that hydraulic fracturing might reflect the necessity of applying new technology to extract oil and gas to maintain the existing fossil fuel economy and capitalist system more generally, for instance, the technology is likely to be supported by people with individualist and hierarchical biases, for whom free markets and personal autonomy (individualists) and maintaining the existing social order (hierarchists) is valued. Conversely, this same technology is likely to be opposed by those with stronger egalitarian predispositions, who may perceive hydraulic fracturing as yet another means of exacerbating inequalities in the existing social order, through unfettered capitalistic development. Evidence of cultural biases shaping attitudes toward risks and new technologies abounds in the literature (Boudet et al., 2014; Kiss et al., 2018; Lachapelle and Montpetit, 2014; Swedlow, 2011), with some research suggesting that the relationship between cultural biases and attitudes toward hydraulic fracturing is most pronounced at the national level, where general beliefs are most likely to serve as heuristics in the formation of opinion (Evensen and Stedman, 2016). In light of such theory and evidence, we have good reason to expect cultural biases identified in the cultural theory of risk to shape Canadian attitudes toward hydraulic fracturing at the national level as well.

H1a: The stronger the individualistic bias, the greater the support for hydraulic fracturing.

H1b: The stronger the hierarchical bias, the greater the support for hydraulic fracturing

H1c: The stronger the egalitarian bias, the lower the support for hydraulic fracturing.

The cultural biases identified by the cultural theory of risk may also be expected to shape public attitudes toward hydraulic fracturing in different ways. For instance, after demonstrating that the relatively high degree of opposition toward hydraulic fracturing in the province of Quebec (70%) is in large part driven by the prevalence of egalitarian values, Lachapelle and Montpetit (2014) speculate that attitudes toward this issue in Canada might be sensitive to the national origin and status of companies undertaking hydraulic fracturing in the country, such that attitudes might be more positive if undertaken by Canadian or government-owned corporations. To fully understand why this might be the case, a brief history of Canadian economic nationalism is relevant here. Canada has a long history of a mixed economy (i.e. a mix of government and private ownership), and this greater tolerance for state intervention is distinct from what prevails in the United States. It also has a long history of economic nationalism, and in particular, anti-Americanism, stemming from the perceived take-over of the Canadian economy by American interests (Granatstein, 1996; Hurtig, 2002). From Sir John A. Macdonald's National Policy (1989) to Pierre-Elliot Trudeau's National Energy Program (1980), Canadian politicians and intellectuals have sought to limit Canada's dependence on external markets and capital, while maintaining some degree of control over the Canadian economy (Azzi, 1999; Clarkson, 2002; Innis, 1956). The annual Edelman Trust Barometer (2018) surveys further reveal that Canadians significantly trust companies headquartered in the United States less than those headquartered in 10 other countries.

Given the history of Canadian economic nationalism, and in light of the relatively low level of trust accorded by Canadians to American corporations, we might hypothesize that public attitudes toward hydraulic fracturing in Canada might be, at least in part, shaped by an Anti-American bias. If Canadian economic history is at all relevant, we should expect to see significantly less support for fracking in Canada if undertaken by an American corporation (H2a). Insights from the cultural theory of risk further suggest this effect should be conditioned by an individual's cultural biases. In particular, egalitarianism might lead one to perceive American corporations unfairly imposing costs on local populations and reaping most of the profits for shareholders in the United States, while believing that a state enterprise would be more responsive to the broader public interest. Such biases might predispose egalitarians to be more supportive of nationalizing resources through state-owned development, and therefore be more supportive of hydraulic fracturing if undertaken by a state-owned company, relative to an American one (H2b). Conversely, we might expect the clear in- and out-group boundaries of social demarcation valued by hierarchism to be associated with greater national pride, and therefore, hierarchical biases ought to be associated with even greater support for hydraulic fracturing when undertaken by a Canadian corporation, as opposed to a foreign one (H2c). Finally, we might expect individualists to be neither resource nationalists (like egalitarians) nor economic nationalists (like hierarchs). Rather, predispositions for free markets, freedom and choice ought to lead individualists to not differentiate between Canadian or American corporations, but instead make hydraulic fracturing relatively less attractive when undertaken by a government-owned (as opposed to private) corporation (H2d).

[2] Although much of the existing literature employs the phrase "cultural worldviews," we follow earlier theorists who helped develop the theory in using the term "cultural bias" to refer specifically to the shared values and beliefs that are posited to shape perceptions of new technologies (Thompson et al., 1990; Dake, 1992).

H2a: Support for hydraulic fracturing will be lower if undertaken by an American, rather than Canadian, corporation.

H2b: Egalitarian biases produce greater support for hydraulic fracturing when the company is government-owned.

H2c: Hierarchical biases produce greater support for hydraulic fracturing when the company is Canadian rather than American.

H2d: Individualist biases produce less support for hydraulic fracturing when the company is government-owned rather than privately owned (regardless of whether American or Canadian).

In addition to these biases, the literature suggests a number of other factors ought to be important in shaping attitudes toward fracking in Canada. In particular, prior experience with the oil and gas industry, and awareness of fracking, have been examined. In this vein, several scholars point to the uneven distribution of hydraulic fracturing activity as particularly relevant (Montpetit and Lachapelle, 2017; Rivard et al., 2014). According to these scholars, the public backlash against HF experienced in some Canadian jurisdictions is attributable to the relative unfamiliarity of large-scale oil and gas development in these provinces. Existing research seeking to examine the relationship between issue familiarity and attitudes toward hydraulic fracturing, however, have found mixed results, with different studies finding positive, negative, and weak correlations between familiarity and support (Pew, 2012; Boudet et al., 2014; Willits et al., 2016; O'Connor and Fredericks, 2018).

A potential reason for these mixed findings may be due to contextual differences in media coverage. According to this view, media coverage may vary across regions, thus accounting for differences in the effect of issue familiarity across contexts. Examining media coverage in four Quebec and three British Columbia news papers, Montpetit and colleagues (2018; 2016) show that the shale gas issue was much more prevalent in Quebec newspapers relative to those studied in British Columbia, and argue that the overwhelmingly negative coverage in Quebec contributed to higher levels of public opposition and, ultimately, to the government's decision to enact a moratorium in 2012. Other research has further observed marked differences in regional coverage, with greater emphasis on economic benefits in provinces where oil and gas play an important role in the economy (e.g. Saskatchewan), and more focus on environmental risks (particularly water pollution) in regions with a moratorium on fracking (e.g. Nova Scotia) (Olive, 2016). Weather due to differences in oil and gas dependence or in media coverage, this research suggests there should be an interactive relationship, leading us to expect geographic context to moderate the effect of issue familiarity on attitudes toward fracking (H3).

H3: The relationship between issue familiarity and attitudes toward hydraulic fracturing is conditioned by region, such that issue attention will increase support in regions more dependent on oil and gas development (e.g. the prairie provinces), and decrease support in regions where economies are less dependent on oil and gas (e.g. eastern Canada).

Finally, a related body of work has built a strong case against a simplistic interpretation of the so-called knowledge-deficit model of opinion formation, which suggests that individual attitudes ought to converge as they become informed about issues surrounding new technologies. A wealth of empirical research has shown that public opinion formation on complex, scientific issues is more complex than this model suggests (Nisbet, 2005). For instance, this research has shown that individuals engage in the reinforcing processes of biased information retrieval and assimilation, actively seeking out information that reinforces one's predispositions and rejecting as invalid information that challenges one's priors (Kahan et al., 2011; Lachapelle et al., 2014b). Building on this research, Lachapelle and Montpetit (2014) find an interactive relationship between self-reported issue familiarity and egalitarian biases. Given the prevalence of overwhelmingly negative media coverage of this issue in Quebec, which framed the issue as one of foreign corporations profiting from the risks imposed on a large segment of the Quebec population, it makes sense that such negative press resonated with a largely egalitarian population, to produce overwhelming opposition. Conversely, we might expect those with more individualist and hierarchical cultural biases to be less affected by such information, given the well-documented tendency of people to discredit information that does not fit their priors (Kahan et al., 2011; Lachapelle et al., 2014b). Applied to the Canadian case, we expect to see an interactive relationship between issue familiarity and cultural bias.

H4: The relationship between cultural bias and attitudes toward hydraulic fracturing is conditioned by issue familiarity, such that stronger egalitarianism will lead to significantly less support amongst more familiar individuals, while stronger individualistic and hierarchical biases will lead to greater support for hydraulic fracturing when they are more familiar with the issue.

3. Methods

To test these hypotheses, a survey experiment was embedded in a nationally representative survey of adult (aged 18 and over) Canadians (n = 2012). The survey was administered as part of a broader project measuring cultural biases and perceptions of risk across a broad range of issues in Canada. Data were collected between November 29th and December 6th, 2016, using a self-administered Computer-Assisted Web Interface (CAWI) approach. This web-based survey was administered by a Canadian market research firm, Léger, relying on the firm's panel of over 400,000 Canadians, 61% of which were recruited randomly over the phone. Of the 6468 email invitations sent to panellists, 2012 interviews were completed, representing a participation rate of 31%. The sample was constructed using a regionally stratified approach to ensure broad coverage across Canada's ten provinces. The data were further weighted to gender, age and region using the latest population estimates from Statistics Canada.

The resulting national sample with relatively large regional subsamples provides several advantages that are relevant for the research aims here. In particular, the national-level focus allows us to examine whether or not there is a nationalist bias with respect to public acceptance of hydraulic fracturing in Canada. The national level sample further allows us to compare the structure of public opinion at different scales (c.f. Evensen and Stedman, 2016). This issue has yet to be fully examined in Canada, with existing work tending to focus on one or two Canadian regions at a time (Evensen and Stedman, 2017b; O'Connor and Fredericks, 2018; Lachapelle et al., 2014b; Lerner, 2014; Montpetit and Lachapelle, 2017). The need for broader, inter-regional comparisons is pressing, as these can help move beyond place and context, in order to ascertain the robustness of results when put to a national sample, as well as the extent to which findings from previous research are generalizable to other regions in Canada. Moreover, the national-level sample upon which this study relies also provides an opportunity to control for some of the "local bias" that exists in areas where the local risks and benefits of HF are relatively more salient (Lachapelle et al., 2014a; Thomas et al., 2017). In so doing, the national-level focus provides an ideal testing ground for assessing whether or not Canadian public attitudes toward hydraulic fracturing are shaped by broader environmental concerns around, for instance, the impact of continued oil and gas development for climate change (c.f. Evensen and Brown-Steiner, 2017).

3.1. Measures

The dependent variable in this study is a respondent's level of support or opposition to hydraulic fracturing. Measurement of this attitude was preceded by a brief preamble, which read:

> *New technologies applied to shale rock formations have made once hard-to-reach natural gas deposits commercially viable across parts of Canada. This process, known as hydraulic fracturing, involves injecting a*

mixture of water, sand and chemicals deep below the surface at very high pressure in order to break sedimentary rock and release the trapped oil and gas.

This introductory text ensured that all respondents had a very basic understanding of the issue at hand. The preamble intentionally avoided use of the term "fracking." Although this more colloquial term is likely to be more familiar than the technical "hydraulic fracturing," the former has been shown to be more polarizing, often evoking negative emotions, leading to significantly higher risk perceptions and overall levels of public opposition (Clarke et al., 2015; Evensen et al., 2014).

Immediately following this introduction, respondents were asked, "How much have you heard about the process of hydraulic fracturing?" This variable was measured on a four-point scale with considerable variation across the "Nothing at all" (15%), "A little" (28%), "A moderate amount" (38%), and "A lot" (20%) response categories. While such self-reported measures are more subjective than actual tests of knowledge (c.f. Stedman et al., 2016) they have been used in previous research (Pew, 2012; Boudet et al., 2016) and provide some insight into people's level of cognitive engagement with this issue, or at least issue familiarity more generally, in that those responding "A lot" are likely to have given considerably more thought than those who have heard "Nothing at all" about hydraulic fracturing. Because this variable is used in interactions with other variables, we standardize this variable in all subsequent analyses, with a mean of zero, and coded so that larger (positive) values of this variable reflects greater familiarity than the sample average.

Next, the survey measured respondents' level of support for hydraulic fracturing, asking them to indicate their level of support or opposition, on a 0 to 10 scale, to "…the use of hydraulic fracturing to extract natural gas from shale rock deposits in Canada." This question was part of an embedded experiment, with respondents randomly assigned to one of four groups. In the control condition (n = 502), 25% indicated strong opposition (score of 0 or 1), 7% indicated strong support (score of 9 or 10), and 27% indicated neither support nor oppose (assigning a score of 5). The question used to measure support among respondents assigned to the other three experimental conditions was identical, but specified to respondents that the hydraulic fracturing would be undertaken by a Canadian, American, or government-owned corporation. Results from this experiment are examined in Section 4.1.

In light of the well-documented regional differences in terms of hydraulic fracturing activity we assigned respondents to one of five major regions depending on where in the country they live. These regions include the Atlantic Canadian provinces (Newfoundland, Nova Scotia, New Brunswick, and Prince Edward Island, n = 239), Quebec (n = 473), Ontario (n = 443), the Prairies (Manitoba, Saskatchewan and Alberta, n = 436) and British Columbia (n = 420). While significant shale resources are found in Canada's territories (Council of Canadian Academies, 2014), obtaining opinion data from these northern regions is difficult, due to their relatively small population and issues regarding Internet access. As a result, our survey was unable to reach people living in the Northwest Territories, Yukon and Nunavut, which is (regrettably) typical in studies of Canadian public opinion (Mildenberger et al., 2016). The resulting regional variable thus provides a rough proxy for regionally specific context. While this measure is no substitute for physical proximity to sites of active drilling (c.f. Alcorn et al., 2017; Boudet et al., 2018; Clarke et al., 2016; Lachapelle et al., 2014a), this classification nevertheless differentiates between regions that are (not) experiencing shale gas production. It also maps onto the region-specific treatment accorded to hydraulic fracturing across Canadian media outlets (Olive, 2016; Montpetit et al., 2016).

Our measures of cultural biases are adapted from the literature on cultural theory (CT) (Douglas and Wildavsky, 1982; Kahan and Braman, 2006; Kahan et al., 2011). We further refined these measures following a series of focus groups conducted in 2013 that were designed to help us better tap into the idiosyncrasies of Canadian culture (Montpetit et al., 2017). These items ask respondents to indicate their level of agreement or disagreement on a six point scale, ranging from strongly disagree to strongly agree. Following a principal components analysis, we identified four distinctive value orientations – egalitarianism, individualism, hierarchism, and fatalism. For the purpose of the present analysis, we include only the first three as fatalism offered very little explanatory power to our models. We further retained only those items with factor loadings above 0.5. We subsequently predicted factor scores for each value inclination using the nine items highlighted in Table A2 of the Appendix, allowing for measures that account for the relative importance attributed to each item within a given factor for each individual. The result is a set of three reliable measures with strong construct and face validity that are mean-centered with a standard deviation of 1, and coded such that positive (negative) values indicate a larger (smaller) than average cultural bias.

3.2. Other variables

In addition to our primary independent variables of interest, we included a number of other variables identified in the literature.[3] This includes a measure of climate change risk perception. We include this as a covariate in light of the salience of the climate change issue for some of the opponents of HF in Canada, despite the fact that previous research finds a limited association between hydraulic fracturing and climate change in the United States (Evensen and Brown-Steiner, 2017). Specifically, we developed a composite measure that was part of a larger risk battery in the survey questionnaire. We measured respondents' risk perceptions on a range of climate change consequences, including bio-diversity loss, extreme heat, sea-level rise, water shortages, flooding and wildfires. The specific question draws directly from the literature on risk perceptions (Kahan et al., 2012) and asked respondents to indicate, on a 0 to 10 scale, how much risk they "… believe each of the following poses to human health, the environment, safety, or prosperity?" This variable (M = 6.78; SD = 1.96) was subsequently standardized and coded such that higher (lower) scores indicate greater (weaker) risk perceptions from climate change.[4]

Finally, we included a number of other variables commonly employed as controls in studies of environmental attitudes. In particular, we include controls for gender, education, and age, which can influence environmental attitudes (Jones and Dunlap, 1992), including in the area of hydraulic fracturing (Boudet et al., 2016; Lachapelle, 2017; O'Connor and Fredericks, 2018). We code gender so that respondents identifying as female are assigned a value of 1, and those identifying as male are assigned a value of 0. Similarly, we operationalize education as a dichotomous variable, with those with a university education coded as 1, and those without a university degree coded as 0. We treat age as a continuous variable that was generated by subtracting responses to the question "In which year were you born" from the year the survey was conducted (i.e. 2016). In light of the fact that the survey was administered in both official Canadian languages, we also included a control for language, coded 1 for French and 0 for English. Descriptive statistics for these variables are provided in Table A1 of the Appendix.

[3] We did not include a measure of left-right self-placement (e.g. ideology) as a covariate in the results reported here. During the process of peer review, all of the analyses were subsequently re-run with ideology included. Since we are primarily interested in unpacking the role of cultural biases, and since the relative influence of cultural biases have been shown to be more important than standard measures of ideology in our other work (Kiss et al., 2018), however, we do not report these results here. All results reported in this article are robust to the inclusion of ideology.

[4] The survey instrument also included a risk battery that included the general label "climate change" as a single item. Robustness checks indicate that results are nearly identical regardless of whether the single- or multiple-item measure is used.

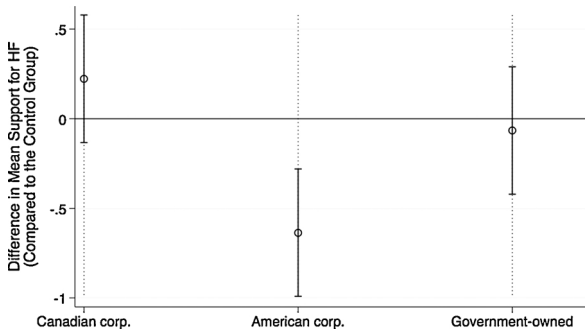

Fig. 1. Effect of attributing HF to Canadian, American, and Public Corporation, relative to Control Group.

4. Results

4.1. Is there a nationalist bias?

Given the experimental nature of the primary dependent variable of interest, we begin with an analysis of the embedded experiment. To examine whether or not Canadian attitudes toward hydraulic fracturing exhibit a nationalist bias, we first performed a one-way analysis of variance (ANOVA) on our survey experiment, and find that attitudes toward hydraulic fracturing are sensitive to information cues that specify the origins and ownership of corporations undertaking hydraulic fracturing in Canada. Specifically, we compare the effect of attributing hydraulic fracturing to a Canadian corporation (n = 503), an American corporation (n = 502), a government-owned (i.e. public) corporation (n = 505), and a control condition in which no such cue was offered (n = 502). We found that this experiment had a significant effect on support for hydraulic fracturing at the $p < 0.000$ level [$F(3, 2008) = 8.13$, $p = 0.000$]. We subsequently ran pairwise comparisons, and plotted the difference in means between each treatment group and the control group, along with 95% confidence intervals (Fig. 1).

Fig. 1 presents the effect of attributing HF in Canada to a Canadian, American, or government-owned corporation on attitudes toward fracking, relative to a control group where no such information is presented. Specifically, it plots the marginal effect (i.e. discrete change in support) conditional upon treatment assignment. As shown, attributing HF to an American corporation decreases support by a relatively modest but statistically significant amount. No other treatments were found to be significant. Post hoc comparisons using the Tukey HSD test further indicated that support for HF was significantly lower in the "American corporation" group relative to the control group (-0.635 ± 0.181, $p = 0.003$), as well as in the "American corporation" compared to the "Canadian corporation" group (-0.858 ± 0.181, $p = 0.000$). These pairwise comparisons further reveal that support for hydraulic fracturing was significantly higher in the "government-owned corporation" group relative to the "American corporation" group (0.570 ± 0.181, $p = 0.009$). However, we found no statistically significant differences between the "Canadian corporation" and control groups (0.222 ± 0.181, $p = 0.608$), or between the "government-owned" and control groups (-0.065 ± 0.181, $p = 0.984$). In line with expectations these results suggest Canadians exhibit a nationalist (or more precisely, anti-American) bias in support of hydraulic fracturing in Canada. All subsequent models thus control for treatment group assignment in the analysis of results.

To examine our hypotheses regarding the effects of cultural biases (H1a-H1c) and corporate ownership (H2a-H2d), we estimate three regression models, regressing support for HF on an interaction between each of the cultural biases and treatment assignment. Each model controls for socio-demographic characteristics, including gender, education, age, and language. The regression results (summarized in Table A3) find support for the first set of hypotheses. Specifically, each of the coefficients for the three cultural biases are significant in models M1 to M3. Consistent with expectations, the significant coefficients indicate that, in the control condition, stronger individualistic (H1a) and hierarchical (H1b) biases are associated with greater support, while a stronger egalitarian bias (H1c) is associated with significantly greater opposition (i.e. lower support). Models M1 to M3 further support H2a, which hypothesized that attributing hydraulic fracturing to an American corporation should lead to a decrease in support. Across all three models, a negative and significant coefficient indicates that, holding the values of all other variables at their mean, support decreases when the question specifies an American corporation, relative to the control condition where no information is provided.

Results from this first set of models (M1 to M3 in Table A3) however find only partial support for hypotheses H2b to H2d. Indeed, these models show that only the interaction between egalitarian cultural bias and assignment to the government-owned treatment group is significant. Specifically, a positive and significant coefficient (0.44) on the interactive term *Egalitarian*Public* in M1 indicates that the effect of egalitarian bias on support for HF when undertaken by a state-owned corporation is significantly *less negative* than when corporate ownership details are left unspecified in the control condition. In other words, the negative relationship between egalitarian bias and support for hydraulic fracturing is attenuated when the question specifies that a government-owned corporation is involved. However, this effect size (0.45) is not large enough to cancel the relatively more powerful, negative "main effect" (-1.37) of egalitarian bias that is highly significant under the control condition (i.e. when the treatment group is set at 0), providing partial support for the hypothesis (H2b) that hydraulic fracturing becomes relatively more palatable for egalitarians when undertaken by a state-owned corporation. Conversely, the non-significant coefficients for the interaction between the attribution experiment and the other cultural biases indicate, for instance, that the positive and significant "main effect" of *Hierarchical bias* on support for HF in the control group (no cue) is not significantly more positive in the "Canadian corporation" group.

While these results suggest that corporate ownership exerts a weak and partial moderating role on the effects of cultural biases, the regression results in Table A3 do not provide a direct test of hypotheses H2b and H2d. Recall that these three hypotheses specify the effects of cultural bias should be most pronounced comparing across different sets of treatment conditions (or types of corporate ownership), not necessarily the control. For instance, H2b specifies that egalitarian biases should be associated with significantly greater support for HF when conducted by a government-owned corporation, relative to an American one, given the latter's perceived effect on economic equality and the distribution of risks and benefits in Canada. For hierarchism, the relevant comparison in H2c is between a Canadian and American corporation. And for individualism, H2d specifies the relevant comparison is between a public (i.e. government-owned) and private corporation (we combine experimental prompts attributing HF to a Canadian/American corporation). To test these hypotheses directly, we predict scores on the dependent variable at representative[5] values of egalitarianism, individualism, and hierarchism for the specific corporate types specified in H2bA to H2c. We then plot the predicted scores (i.e. margins). The results, presented in Fig. 2, illustrate partial support for our hypotheses.

Fig. 2 provides some evidence to suggest that the strong relationship between cultural biases and support for HF is partially conditioned by cues regarding corporate ownership. Beginning with the top left panel (2a), the plot shows that predicted levels of support for HF decline with stronger egalitarian biases. However, the negative slope representing support for HF when undertaken by an American corporation (darker

[5] These representative scores range from -1.5 to +1.5 standard deviation units on each of the cultural bias measures.

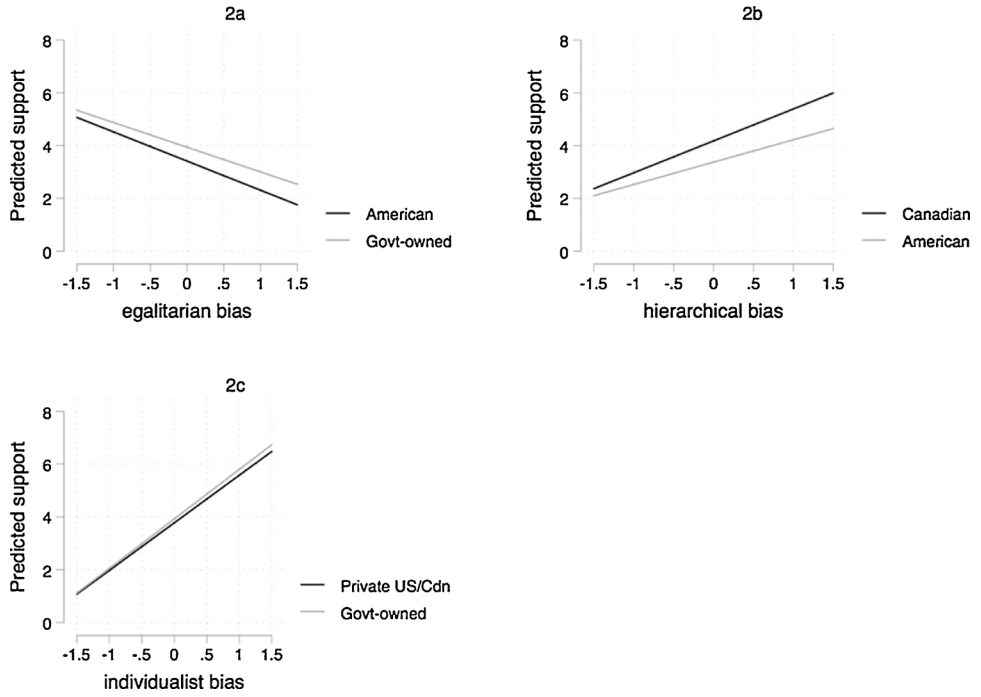

Fig. 2. Predicted level of support for HF by cultural bias conditional on treatment group.

line) is steeper than that representing support for HF under the "government-owned" treatment, suggesting the negative effect of egalitarian biases is somewhat attenuated by a state-owned corporation undertaking the fracking. While people with strong egalitarian biases are predicted to be more supportive of HF if undertaken by a government-owned, as opposed to American, corporation (H2b), the slopes are not significantly different at conventional levels (i.e. $p < 0.05$). Conversely, in the top right panel, we find that the positive relationship between hierarchical bias and support for hydraulic fracturing is significantly greater under the experimental condition specifying that a Canadian, as opposed to an American, corporation is involved. This is consistent with H2c and suggests hierarchs are especially prone to be economic nationalists. Finally, and in contrast to H2d, the strong, positive effect of individualist biases on support for HF appears to be unaffected by cues regarding corporate ownership, suggesting that individualists support for oil and gas extraction trumps their dislike of government intervention in the economy.

4.2. Issue familiarity across regions

We further explored the structure of Canadian attitudes toward hydraulic fracturing by looking at the effect of issue familiarity. We conceptualize issue familiarity as having at least two dimensions, including personal experience (e.g. living in an area that is relatively more dependent on unconventional gas development) and more cognitive factors associated with greater knowledge and awareness of hydraulic fracturing. To capture the potential effects of these sets of factors, we regressed attitudes toward hydraulic fracturing on region of residence, self-reported levels of issue familiarity, as well as an interaction between the two. All of these models included controls for gender, education, age, and language of the interview, as well as a control for the experimental treatment to which groups were assigned. Results (found in Table A4 of the Appendix) show that, relative to Quebec (the reference case), public support for the use of hydraulic fracturing is significantly higher in the Prairie provinces of Alberta, Saskatchewan and Manitoba and in Ontario. Model 5 in Table A4 further shows that self-reported issue familiarity is associated with significantly less support. Consistent with previous work, these models also show that women hold significantly different (i.e. less supportive) attitudes toward fracking than men, while coefficients on the other controls are not significant.

To test the idea that the relationship between issue familiarity and attitudes toward hydraulic fracturing is conditioned by region (H3), we included a multiplicative interaction term between issue familiarity and region of residence (Model 6 in Table A4). The results – illustrated in Fig. 3 – indicate that the negative effect of issue familiarity on public attitudes toward hydraulic fracturing is significantly more negative in the province of Quebec (the regional baseline, represented by the black line), which is a province with extremely limited experience with oil and gas development, and where previous research documented overwhelmingly negative media coverage of hydraulic fracturing (Montpetit et al., 2018; 2016). Conversely, the positive and significant coefficient on the interaction term for the prairie provinces of Alberta, Saskatchewan and Manitoba indicates that the effect of issue familiarity is significantly more positive in this region, relative to its effect in Quebec. The size of this coefficient is slightly larger than the negative "main effect" of issue familiarity in the regional baseline, which results in a weak but positive slope for issue familiarity in the Prairies (blue line in

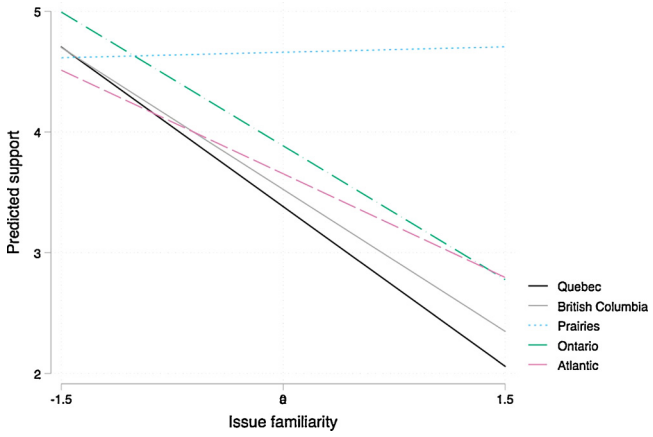

Fig. 3. Predicted level of support for HF by issue familiarity and region.

Table 1
OLS Regression Results for Fully-Specified Models.

	M7	M8	M9	M10	M11
Treatment					
Canadian corp.	0.23	0.25	0.23	0.27	0.25
	(0.17)	(0.15)	(0.15)	(0.15)	(0.15)
American corp.	−0.63***	−0.56***	−0.58***	−0.58***	−0.56***
	(0.17)	(0.15)	(0.15)	(0.15)	(0.15)
Govt-owned	0.01	0.03	0.03	0.05	0.03
	(0.17)	(0.15)	(0.15)	(0.15)	(0.15)
Region					
British Columbia	0.01	0.06	0.08	0.05	0.06
	(0.23)	(0.22)	(0.22)	(0.22)	(0.22)
Prairies	0.92***	0.61**	0.62**	0.60**	0.61**
	(0.23)	(0.22)	(0.21)	(0.21)	(0.22)
Ontario	0.35	0.23	0.22	0.22	0.23
	(0.23)	(0.21)	(0.21)	(0.21)	(0.21)
Atlantic	0.24	0.10	0.13	0.07	0.10
	(0.24)	(0.22)	(0.22)	(0.22)	(0.22)
Issue familiarity	−0.60***	−0.50***	−0.49***	−0.50***	−0.51***
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
CC risk	−0.84***	−0.43***	−0.43***	−0.42***	−0.43***
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Egalitarianism		−0.52***	−0.51***	−0.46***	−0.52***
		(0.08)	(0.08)	(0.08)	(0.08)
Individualism		1.29***	1.22***	1.23***	1.28***
		(0.09)	(0.09)	(0.09)	(0.09)
Hierarchism		0.00	−0.02	−0.02	−0.00
		(0.08)	(0.08)	(0.08)	(0.08)
*Egal*Familiar*			−0.23***		
			(0.07)		
*Ind*Familiar*				0.30***	
				(0.08)	
*Hier*Familiar*					0.03
					(0.07)
_cons	3.39***	3.61***	3.59***	3.61***	3.61***
	(0.33)	(0.30)	(0.30)	(0.30)	(0.30)
N	2011	2011	2011	2011	2011
adj. R^2	0.17	0.29	0.30	0.30	0.29

Notes : Standard errors in parentheses. All models control for age, gender, education, and language (not shown).
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Fig. 3). This finding confirms H3, and is consistent with previous research that has documented more positive media coverage of this issue in the Prairies (Olive, 2016). Meanwhile, the negative effect of issue familiarity on support for HF is similar to that found in Quebec for all of the other regions, as illustrated in Fig. 3, and as is clear from the non-significant interaction terms in Table A4 for these other regions. Overall, this suggests that, consistent with H3, the effect of issue familiarity is conditioned by region.

4.3. Issue familiarity and cultural biases

A final set of OLS models were estimated to examine the role of cultural biases and their interaction with issue familiarity (H4). Each one of these more fully-specified models included a climate change risk perception measure as well as the controls used earlier for gender, education, age and language (not shown). Results are presented in Table 1.

As shown in Table 1, we again find that, relative to the control condition where no information on corporate ownership is provided, the small negative effect of attributing hydraulic fracturing to an American corporation is associated with a significantly lower level of public support across all models. The analyses further demonstrate the robustness of other findings, with issue familiarity consistently associated with significantly lower support, and residence in the prairie provinces associated with significantly greater levels of public support relative to attitudes in Quebec. All models also include a measure of climate change risk perception, which is consistently associated with greater opposition toward HF in Canada. This suggests, that, at least to some extent, Canadians opposed to HF are drawing some connection between this technology and global climate change. Overall, the first model (M7) – which includes the treatment assignment, climate change risk perception, region or residence, and the controls for age, gender, education and language – explains about one-fifth of the variation in Canadian attitudes toward hydraulic fracturing.

Explained variance increases significantly when cultural bias measures are included [$F(3, 1994) = 117.18$, $p = 0.0001$]. As shown in Models M8 to M11, attitudes toward hydraulic fracturing in Canada are strongly conditioned by egalitarianism and individualism, but not

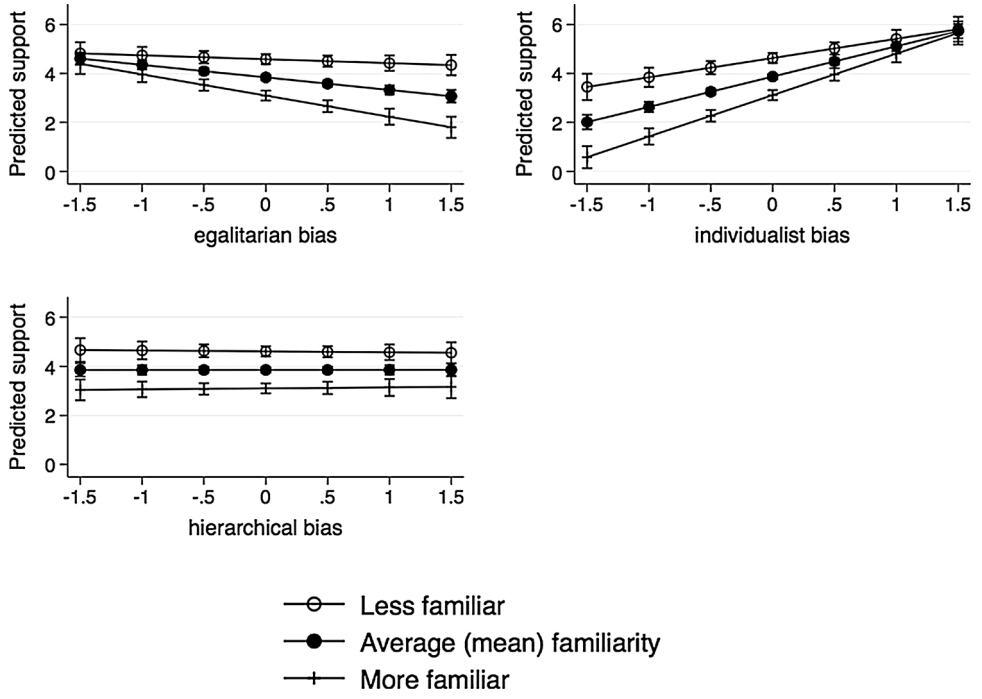

Fig. 4. Effect of cultural biases on support for HF, conditional on issue familiarity.

hierarchism. Additionally, results presented in M9 to M11 provide evidence to (partially) support H4. While the interaction between egalitarian and individualist biases, and issue familiarity, are significant and in the hypothesized direction, the coefficient for the *Hier*Familiar* interaction is not. To get a better handle on interpreting these interactions, we predict levels of support for hydraulic fracturing across the range of observed scores on egalitarianism, individualism, and hierarchism, at specific levels of issue familiarity. The results are presented in Fig. 4.

Fig. 4 illustrates the effect of the three cultural biases on support for hydraulic fracturing, conditional on levels of issue familiarity, which we set at one and a half standard deviations above (i.e. "More familiar") and below (i.e. "Less familiar") the sample mean ("Average familiarity"). The top left panel shows that at very low levels of egalitarian bias (e.g. anti-egalitarianism), support is relatively high, regardless of issue familiarity. Stronger egalitarian biases tend to decrease support, but the negative effect of egalitarian bias is amplified (i.e. there is a steeper slope) as individuals become more informed. The effect of egalitarianism is significantly less negative when respondents are relatively unfamiliar with HF. Conversely, the top right panel shows that individualism is a strong predictor of support, but that the size of this effect (indicated by the slope) similarly varies by level of issue familiarity. Indeed, the positive effect of individualist bias on support for hydraulic fracturing is especially pronounced when individuals are more familiar than average. Essentially, issue familiarity is significantly *less* polarizing as individualist biases increase. This result provides further support for the idea that issue familiarity moderates the effect of cultural biases (H4). However, the bottom left panel offers no support for H4. Indeed, the slopes are relatively similar and flat at all three levels of issue familiarity, suggesting that hierarchism is weakly related to support for HF at all levels issue familiarity. Meanwhile, the bottom left panel also illustrates the significant and negative "main effect" of issue familiarity on support, as less familiar individuals tend to be relatively more supportive, regardless of level of hierarchical bias.

In sum, we find considerable support for most of our hypotheses, summarized in Table 2.

5. Discussion

As suggested by the foregoing, many of the drivers of public attitudes toward hydraulic fracturing found in previous research on Canada are also relevant when looking at attitudes at the national level. Consistent with this work, we find, inter alia, that issue familiarity generally makes people less supportive of hydraulic fracturing, and we further confirm that attitudes in Canada are strongly shaped by egalitarian and individualist cultural biases. However, we also demonstrate that the role of issue familiarity and cultural biases in shaping attitudes toward hydraulic fracturing are relatively more complex than previously understood. For instance, while issue familiarity has been shown to correlate negatively with perceived economic benefits and positively with perceived environmental risks in New Brunswick and British Columbia (O'Connor and Fredericks, 2018), we show that the relationship between familiarity and attitudes is different in regions that are more heavily dependent on oil and gas extraction (i.e. the Prairies). Though we do not test exposure to media portrayals of fracking directly in this study, our findings are consistent with previous research that has identified broad differences in media coverage of hydraulic fracturing across Canadian regions (Montpetit et al., 2018; 2016; Olive, 2016). Specifically, our findings are consistent with the conclusion that these media frames may have an effect on public attitudes. In turn, we also show that the effect of cultural biases are mediated by issue attention, which would also be consistent with this conclusion. Indeed, many of the risks associated with HF and diffused by Canadian media are highly salient for egalitarians (e.g. environmental quality; equal distribution of wealth; the right of local communities to decide). In this light, it makes sense that greater egalitarianism leads to significantly less support when individuals are relatively more familiar with the issue, as only when people are informed may they come to see particular issues as a threat to their values and identities. Greater self-reported issue familiarity may thus be capturing exposure to media coverage of these risks, which have been shown to be quite prevalent in the Canadian mainstream media (Olive, 2016; Montpetit et al., 2016), serving to "activate" egalitarian biases. Meanwhile, the effect of issue familiarity seems to diminish with stronger individualism, which though puzzling, might be interpreted as these biases "crowding out" the high profile risks often covered in Canadian media. For hierarchs, the effect of issue familiarity is more constant, suggesting that the risks and benefits of hydraulic fracturing do not resonate as much with this cultural bias.

The analysis here further reveals that the role of cultural biases in shaping Canadian attitudes toward HF is at least partially conditioned by cues regarding corporate ownership. Consistent with expectations, we show that such attribution framing is most liable to produce greater support among those with hierarchical biases when Canadian, as opposed to American, corporations are involved. Our analysis also provides some evidence to suggest that the negative effect of egalitarianism on HF support may be attenuated by the perceived benefits of hydraulic fracturing from a government-owned corporation, though contrary to expectations, we find no evidence to support the idea that individualists are more supportive of fracking undertaken by private as opposed to state-owned companies. While these effects are partial and limited, they do suggest that attitudes are susceptible to change in the hypothesized direction when the issue is framed to fit with different sets of values. At the same time, we document a modest but very robust anti-American bias in attitudes toward fracking, such that opposition toward fracking in Canada is most strongly opposed when undertaken by American corporations. Given the role of American multinationals in the global oil and gas industry, as well as the (oftentimes) negative perceptions of American corporations outside of the United States, the prevalence of this anti-American (in some cases, nationalist) bias in other jurisdictions is something future research might wish to pursue.

To be sure, the present study offers some fresh perspective to the literature on attitudes toward hydraulic fracturing in Canada. By examining a large, nationally-representative sample, it offers broader

Table 2
Summary of results for primary hypotheses.

Hypothesis category	Sub-hypothesis	Result
Cultural bias	H1a: individualistic bias → greater support	Supported
Cultural bias	H1b: hierarchical bias → greater support	Partially supported
Cultural bias	H1c: egalitarian bias → less support	Supported
Anti-American bias	H2a: American corporation < control	Supported
Resource nationalism bias	H2b: Egalitarian bias for government-owned > American	Partially supported
Economic nationalism bias	H2c: Hierarchical bias for Canadian > American	Supported
Pro-market bias	H2d: Individualist support for private > public corporation	Unsupported
Issue familiarity and region	H3: issue attention decrease support in all regions except Prairies	Supported
Issue familiarity and cultural bias	H4: issue attention increases (decreases) support among individualists and hierarchs (egalitarians)	Partially supported

regional comparison to see how far findings in previous research travels. The present study also finds that Canadian risk perceptions around climate change consequences, and opposition toward fracking, are positively correlated, which to our knowledge is a novel finding. However, the study is limited in several respects. First and foremost, the instrument was not focussed exclusively on hydraulic fracturing, and offered few opportunities to directly measure some of the mechanisms thought to be at work here, such as exposure to media coverage of hydraulic fracturing. As a result, we can only speculate as to why issue familiarity plays different roles in different regions, and for different sets of cultural biases. Similarly, it is difficult to safely infer a mechanism that is driving the persistent anti-American bias observed in the experimental results at the level of aggregate Canadian attitudes toward HF. To the extent that Canadians are somewhat mistrustful of oil and gas companies (Campbell and Lewis, 2012), and of American corporations more generally (Edelman Trust Barometer, 2018), the treatment may actually be manipulating level of trust, and not an anti-American or nationalist bias per se.

In light of these limitations, future research might seek to analyze these relationships more closely. This might involve collecting more direct measures of key variables at play, and testing each link in the theorized causal chain linking these concepts to attitudes toward hydraulic fracturing (c.f. Evensen and Stedman, 2017a). This future research should include more precise measures for things like risk and benefit perceptions, media exposure, experience, and knowledge, while not ignoring the important role of cultural biases. In so doing, it may be in a better position to adjudicate between whether people with strong cultural biases actively seek information that confirms their predispositions, or whether the same dominant media frames are being filtered through each person's perspective, "activating" cultural biases in some instances but not others? The other avenue worthy of future research relates to how different types of trust in different sets of actors may or may not affect attitudes toward HF in Canada, and in other parts of the world as well (c.f. Neville and Weinthal, 2016; Parkins et al., 2017). Greater attention to areas that have to date received less scholarly attention (e.g. Alberta) seem particularly important, while providing more expansive comparison with a broader set of regions.

Overall, the hydraulic fracturing issue in Canada appears to be culturally polarizing, with significant potential for controversy. To the extent that egalitarian biases are a prominent trait in Canadian political culture (see Fig. A1), framing around the unequal distribution of benefits and risks is likely to resonate with a considerable proportion of the Canadian population. As governments seek to transition their economies away from fossil fuels, the issue of hydraulic fracturing and unconventional gas development more generally will only add to this debate. Existing policy trajectories in Canada suggest public opinion is important, yet research in Canada significantly lags research in other jurisdictions. In this context, greater attention to the drivers of Canadian public opinion, as well as more expansive, systematic, comparative studies – both within Canada and cross-nationally – can provide additional insight in this burgeoning field.

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Declaration of interest

None.

Appendix A

Table A1 presents descriptive statistics for key variables used in the models. All data presented here are in original units of measurement. To facilitate interpretation, we compute the Z-score for issue familiarity and climate change risk perception, and use these transformed variables in all statistical analyses. The transformed variables have a mean of approximately zero, and a standard deviation of 1.

Table A2 presents the nine items used to measure cultural biases. Each item loads onto one of the three factors, or cultural biases shown here. Responses to these questions were subsequently computed to produce factor scores, which situate a respondent on each factor. The regression method used to predict these factors produces a set of standardized scores (similar to a Z-score) with a range within ± 3 and a mean of around 0. Positive (negative) values thus indicate that a particular respondent is located above (below) the sample mean.

Fig. A1 presents the distribution of predicted factor scores for all three cultural biases. To illustrate these distributions, we employed kernal density estimation to estimate the probability density function (PDF) of each predicted factor score (i.e. cultural bias). Since the area under each curve is 1, we can visualize the relative probability of higher and lower cultural bias scores between any two points on the x-axis by looking at the area under the curve between those two points. So, for instance, we can see that the probability of finding people with strong egalitarian biases (i.e. between 1 and 1.5) is much greater than is the probability of finding individuals with strong hierarhical biases (i.e. between 1 and 1.5).

Table A1
Variables and descriptive statistics.

Variable	N	Description	Mean	Standard deviation
Support for hydraulic fracturing (control condition)	502	Measured on 0 (strongly oppose) to 10 (strongly support) scale	3.97	2.89
Support for hydraulic fracturing (Canadian corporation)	503	Measured on 0 (strongly oppose) to 10 (strongly support) scale	4.20	2.85
Support for hydraulic fracturing (American corporation)	502	Measured on 0 (strongly oppose) to 10 (strongly support) scale	3.34	2.78
Support for hydraulic fracturing (Government-owned corporation)	505	Measured on 0 (strongly oppose) to 10 (strongly support) scale	3.91	2.97
Issue familiarity (Unstandardized)	2012	Measured on 0 (heard nothing) to 3 (heard a lot) scale	1.61	0.97
Climate change risk perception (Unstandardized)	2012	Measured on 0 (no risk) to 10 (extreme risk) scale	6.73	1.96
Gender	2012	Dichotomous variable coded male (0) and female (1)	0.44	0.49
Age	2012	Measured in years (sample range from 18 to 96 years old)	56	14.85
Language of interview	2012	Dichotomous variable coded 0 (English) and 1 (French)	0.21	0.41
Education	2012	Dichotomous variable coded 0 (less than University grad) and 1 (University graduate)	0.37	0.48

Table A2
Cultural bias measures.

Cultural bias measures		
Egalitarianism	Individualism	Hierarchism
1. We need to dramatically reduce inequalities between the rich and the poor. 2. Government should provide a decent standard of living for everyone. 3. We need to do more to reduce inequalities between men and women.	1. Free markets – not government programs – are the best way to supply people with the things they need. 2. Stricter environmental laws and regulations cost too many jobs and hurt the economy. 3. Most corporations make a fair and reasonable amount of profit.	1. Society has gone too far in granting gays and lesbians equal rights. 2. We have gone too far in pushing minority rights in this country. 3. A lot of problems in our society come from the decline of the traditional family.

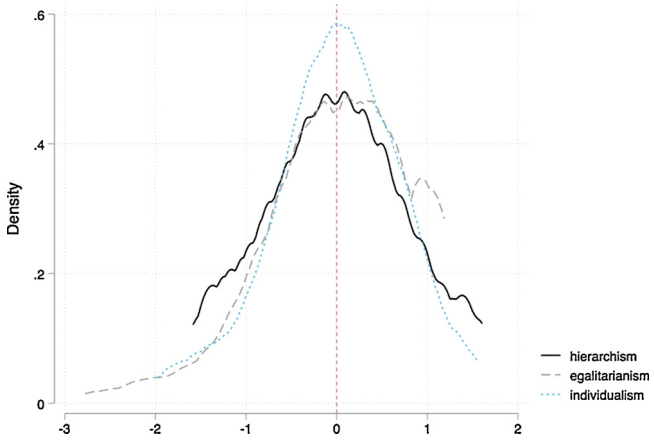

Fig. A1. Distribution of standardized cultural bias scores (predicted factors). Fig. A1 presents the distribution of predicted factor scores for all three cultural biases. To illustrate these distributions, we employed kernal density estimation to estimate the probability density function (PDF) of each predicted factor score (i.e. cultural bias). Since the area under each curve is 1, we can visualize the relative probability of higher and lower cultural bias scores between any two points on the x-axis by looking at the area under the curve between those two points. So, for instance, we can see that the probability of finding people with strong egalitarian biases (i.e. between 1 and 1.5) is much greater than is the probability of finding individuals with strong hierarhical biases (i.e. between 1 and 1.5).

Table A3
Base OLS Models used to Simulate Predicted Support for HF in Fig. 2.

	M1	M2	M3
Attribution treatment			
Control = 0 (no cue)			
Canadian corporation	0.27	0.23	0.24
	(0.17)	(0.17)	(0.16)
American corporation	−0.47**	−0.58***	−0.58***
	(0.17)	(0.17)	(0.16)
Government-owned	0.05	−0.04	−0.02
	(0.17)	(0.17)	(0.16)
Cultural bias*Attribution			
Egalitarian bias	−1.38***		
	(0.15)		
*Egalitarian*Canadian*	0.19		
	(0.21)		
*Egalitarian*American*	0.28		
	(0.21)		
*Egalitarian*Public*	0.45*		
	(0.21)		
Hierarchical bias		0.85***	
		(0.15)	
*Hierarchy*Canadian*		0.36	
		(0.21)	
*Hierarchy*American*		0.00	
		(0.21)	
*Hierarchy*Public*		0.17	
		(0.22)	
Individualist bias			1.58***
			(0.16)
*Individualist*Canadian*			0.40
			(0.22)
*Individualist*American*			0.02
			(0.23)
*Individualist*Public*			0.30
			(0.22)

(*continued on next page*)

Table A3 (*continued*)

	M1	M2	M3
Controls			
Gender (female = 1)	−0.29*	−0.40**	−0.33**
	(0.12)	(0.13)	(0.12)
Education (Uni = 1)	−0.04	0.37**	0.45***
	(0.13)	(0.13)	(0.12)
Age (in years)	−0.00	−0.01	−0.00
	(0.00)	(0.00)	(0.00)
Language (French = 1)	−0.50***	−0.52***	−0.37**
	(0.15)	(0.15)	(0.14)
_cons	4.30***	4.42***	4.28***
	(0.27)	(0.28)	(0.26)
N	2012	2012	2012
adj. R^2	0.13	0.10	0.21

Standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table A4
Base OLS Models used to simulate Predicted Support for HF in Fig. 3.

	M4	M5	M6
Attribution treatment			
Control = 0 (no cue)			
Canadian corporation	0.22	0.20	0.20
	(0.18)	(0.17)	(0.17)
American corporation	−0.64***	−0.66***	−0.70***
	(0.18)	(0.17)	(0.17)
Government-owned	−0.07	−0.04	−0.08
	(0.18)	(0.17)	(0.17)
Region (Quebec baseline)			
British Columbia		0.09	0.14
		(0.24)	(0.24)
Prairie Provinces		1.31***	1.28***
		(0.24)	(0.24)
Ontario		0.49*	0.50*
		(0.24)	(0.24)
Atlantic Provinces		0.24	0.27
		(0.25)	(0.25)
Issue familiarity		−0.62***	−0.88***
		(0.07)	(0.11)
*Familiarity*BC*			0.10
			(0.19)
*Familiarity*Prairies*			0.91***
			(0.18)
*Familiarity*Ontario*			0.14
			(0.17)
*Familiarity*Atlantic*			0.31
			(0.21)
Controls			
Gender (female = 1)		−0.91***	−0.91***
		(0.13)	(0.13)
Education (Uni = 1)		0.22	0.21
		(0.13)	(0.13)
Age (in years)		0.01	0.01
		(0.00)	(0.00)
Language (French = 1)		−0.29	−0.29
		(0.22)	(0.22)
_cons	3.97***	3.48***	3.53***
	(0.13)	(0.34)	(0.34)
N	2012	2011	2011
adj. R^2	0.01	0.09	0.10

Standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

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