

Costs, benefits, and the malleability of public support for “Fracking”



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ABSTRACT

Public opinion plays an important role in shaping the policy debate over hydraulic fracturing at both the state and national level. However, most Americans report having little to no information about this controversial practice that has transformed the U.S. energy market. Employing an experiment embedded on a nationally representative survey, we examine how citizens respond to arguments concerning the costs and benefits of fracking, and incorporate them into their policy preferences. Arguments emphasizing the economic benefits of fracking bolster support for the technique; however, these gains are completely canceled if paired with a discussion of fracking's environmental costs. Additionally, we find mixed evidence of partisan motivated reasoning in how this information is processed. Individuals whose partisan attachments and preexisting beliefs about global climate change conflict are particularly responsive to arguments about the benefits and costs of fracking. Our results have important implications for scholars and policymakers concerned with partisan polarization in public opinion toward energy and environmental policy.

1. Introduction

The exponential increase in hydraulic fracturing, or “fracking,” to extract natural gas has dramatically changed the energy landscape in the United States. While natural gas production plateaued in the late 1990s, the widespread adoption of fracking technology increased natural gas production by 25% from 2007 to 2013. The resulting boom in supply is estimated to have decreased the cost of natural gas by more than 40% (Hausman and Kellogg, 2015, 15). This, in turn, has produced a dramatic shift in the electricity market. Between 2005 and 2014, the fraction of electricity generated from coal decreased from 50% to 37%, while the percentage generated from natural gas rose from 19% to roughly 26%, and renewables grew from just over 2% to under 13% in 2015 (U.S. EIA, 2016). The share of unconventional forms of

natural gas (e.g., shale gas, tight gas, coalbed methane) is forecast to increase from 42% of total U.S. production in 2007 to 64% in 2020 (API, 2016). This increase in energy production has led to the creation of jobs (e.g., estimates range from 48,000 to 100,000 jobs in Pennsylvania alone), and revenues in the billions for each shale deposit (Fischetti, 2010; Kinnaman, 2011).¹

Despite the touted economic benefits, fracking has emerged as a highly polarizing issue in modern politics, since the extraction of unconventional natural gas reserves in the fracking process carries with it serious environmental costs (Israel et al., 2015). To drill a single well, approximately five acres of land are cleared, and a well is drilled 3000–8000 feet below the surface. As shale deposits are only a few hundred meters thick, the drill turns 90° and continues horizontally for up to a mile (Fischetti, 2010). To fracture the rock and release the gas

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¹ This is not to argue that the economic effects of fracking are wholly positive, but simply that proponents of fracking regularly point to its economic benefits. Indeed, the economic calculations are complicated and are contingent on a host of contextual factors. For example, communities that are dependent on natural resources may experience short-term employment and income spikes, but over the long term see relatively high unemployment, poverty, inequality, crime, and lower education attainment (Force et al., 1993; Humphrey et al., 1993; Jacquet et al., 2014; Stedman et al., 2004, 2005). Such resource exploitation usually occurs in short bursts, leading to “boomtown” phenomena that overwhelm housing supplies and burden municipal services and government programs (Jacquet, 2009). When prices invariably drop and the boom busts, property values quickly decline, unemployment spikes, and people flee the area (Buttel and McMichael, 2005; Marchand, 2012). Conversely, if local landowners are able to recover lease and royalty revenues, investments in the local community can lead to potentially long-term positive impacts (Jacquet, 2014).

stored in the shale layer, considerable quantities of water dosed with bactericides, anti-corrosives, and proppants are injected into the well. The term “fracking,” commonly used in public discourse to describe the entire production process, originates from this hydraulic fracturing step.² The resulting “flowback fluid,” which now contains heavy metals, salts and naturally occurring radioactive materials present in the shale, threatens freshwater and groundwater sources with a myriad of public health concerns due to the potentially carcinogenic and toxic nature of some of the fracking fluid components (Colborn et al., 2011; Fishetti, 2010; Krupnick and Gordon, 2015). Moreover, some of the methane, a powerful greenhouse gas, extracted by fracking is vented from the wellhead into the atmosphere. As a result, many scientists argue that the long-term greenhouse gas footprint of shale gas exceeds that of coal or oil (Howarth et al., 2011; Wigley, 2011).³

However, other studies question the extent of fracking's environmental risk. For example, an EPA (2015) assessment found little evidence of systemic pollution of drinking water as a result of fracking, and a report from the MIT Energy Initiative (O'Sullivan and Paltsev, 2012) concluded that fracking admitted only marginally more methane than conventional gas drilling. Reflecting the ongoing debate over fracking's environmental implications, a 2014 Pew Research Center poll of a sample of members of the American Academy for the Advancement of Science found that two thirds of scientists opposed the increased use of fracking, while 31% supported it (Pew, 2015a, 53).

The complicated and contested cost-benefit calculations fracking entails have spurred intense political debates over the extent to which government should regulate the hydraulic fracturing industry (Davis and Hoffer, 2012; Smith and Ferguson, 2013; Warner and Shapiro, 2013). Public discourse over fracking reported in the mass media has also reflected these sharp disagreements over the procedure's relative costs and benefits (e.g. Schor, 2015a, 2015b; Mazur, 2016).

Recent events suggest that public opinion will play a role in shaping fracking's future. For example, widespread public concern over fracking and its threat to groundwater supplies provided valuable political cover for Governor Andrew Cuomo's 2014 decision to ban fracking in New York state (NRDC, 2015). By contrast, greater public support for fracking in Pennsylvania appears to have buoyed development of the Marcellus Shale (McKay et al., 2011; Rabe and Borick, 2013; Theodori et al., 2014; Boudet et al., 2014). As a result, understanding the dynamics driving public support for fracking and its potential to change over time is of immediate policy import.

The debate over fracking and its future is linked to larger questions of energy policy and global climate change. Yet, an important feature distinguishing attitudes toward fracking from related issues is the significant percentage of Americans who admit they lack information about it (Boudet et al., 2014; Wolske et al., 2013). Given low levels of public information, it is unsurprising that past polls suggest many Americans have relied heavily on partisan cues when forming their opinions; fracking enjoys strong support among Republicans and meets with considerably greater skepticism among Democrats (Davis and Fisk, 2014). As a result, and similar to global warming, public opinion on fracking falls sharply along party lines. However, the widespread uncertainty about fracking and what it entails raises an

interesting question: will Americans update their assessments of fracking in response to arguments about its costs and benefits? Would exposure to such information reduce their uncertainty and produce opinion change, or will individuals resist new information that is inconsistent with their partisan predispositions and preexisting beliefs?

To explore the dynamics of public opinion formation on a highly polarized question of energy policy import, we employ an original survey experiment embedded on a nationally representative online survey to answer three main questions. First, to what extent is public support for fracking responsive to arguments concerning the economic and environmental benefits and costs of hydraulic fracturing? Second, to what extent do citizens engage in motivated reasoning when processing information about fracking and incorporating (or refusing to incorporate) it into their policy preferences? Third, to what extent do partisan predispositions and attitudes toward global warming interact to moderate the influence of new information on Americans' support for fracking?

2. Information, motivated reasoning, and public support for fracking

A large literature has examined the foundations of public attitudes toward anthropogenic climate change and measures to address it. One of the main findings of this literature is that over the past quarter century, public opinion toward climate change has polarized dramatically along partisan lines (Krosnick et al., 2000; Dunlap and McCright, 2008; Guber, 2012). As the partisan gap has widened, most Americans' opinions have also hardened, rendering them nearly impervious to new information. For example, in an experimental analysis of support for clean energy alternatives, Akin and Urpelainen (2013) found that various combinations of positive and negative policy frames had virtually no impact on public opinion. While recent research by Deryugina and Shurchkov (2016) found that informing subjects about the extent of the scientific consensus concerning climate change had some immediate influence on beliefs that climate change was occurring, it had no influence on their support for action to address the situation. Instead, many Americans appear to engage in partisan motivated reasoning; that is, they counter-argue against and ultimately reject new information that contradicts their partisan predispositions (Druckman and Bolsen, 2011; Hart and Nisbet, 2012; Bolsen et al., 2014a; Kraft et al., 2015).

Given that the economic, political, and scientific debates over fracking are linked to larger questions of climate change and energy policy, should we expect the dynamics underlying public support for fracking to be any different from those examined in other contexts? A particularly important distinguishing feature of public opinion concerning fracking is the widespread lack of relevant information on which most Americans can draw when forming their assessments of fracking as an instrument of energy policy. Of course, past research has plainly shown that many Americans lack basic political and scientific knowledge (e.g., Carpini and Keeter, 1997; Miller, 1998). However, existing survey evidence suggests that the level of uncertainty among the American public toward fracking may be exceptionally high. For example, a 2013 Pew Poll asked Americans “which natural resource is extracted in a process known as ‘fracking’: natural gas, coal, diamonds, or silicon?” Forty-nine percent of respondents either answered incorrectly or replied that they did not know (Pew, 2013). In a nationally representative survey of Americans' attitudes toward fracking, Boudet et al. (2014, 63) found that more than half of their sample had heard or read either nothing at all or only a little about fracking; consequently more than half did not know or were undecided over whether they supported or opposed the controversial technique. Similarly, in the 2015 National Survey on Energy and the Environment, Borick and Clarke (2016) found that 54% of Americans had either heard either only a little or nothing at all about fracking. And while Wolske and

² Although some have argued that the term “fracking” is potentially problematic because its meaning has evolved over time (Evensen et al., 2014), we use the term in our study because of its ubiquity in both policy debates and in the public sphere. For example, Google's top news stories concerning the topic routinely use “fracking” in the title across sources; a Google News search on 13 December 2016 with the keyword “fracking” reveals over 649,000 stories, whereas *shale oil* or *gas development* are much less likely to populate headlines. Moreover, articles that use these terms are concentrated in more targeted business and energy sector publications. A search with these terms returned approximately 128,000 results, in publications such as *Fortune*, *Environmental & Energy Publishing*, *EcoWatch*, and *PowerSource*.

³ Despite these negative environmental ramifications, proponents of fracking argue that is relatively beneficial for the environment since it reduces the nation's reliance on coal and replaces the lost capacity with cleaner burning natural gas (e.g. Schrag, 2012).

Hoffman (2013) found that awareness appears to be increasing, they note that repeated polls showed significant percentages of Americans report being largely unaware of hydraulic fracturing, while other polls showed only 30% reporting that they have heard “a lot” or “some” about the issue.

In the absence of even basic knowledge concerning what fracking does, let alone detailed information about the costs and benefits of the process, it is perhaps unsurprising that many Americans appear to rely on partisan cues when forming their opinions. For example, a 2014 Pew Poll showed Republicans and Democrats almost exactly reversed on the question of whether they supported an increased use of fracking to increase oil and gas production. Among Republicans, 62% supported fracking while only 25% opposed it. By contrast, among Democrats only 29% backed increased fracking, while 59% opposed it (Pew, 2014). While the divisiveness has remained, support among both parties for fracking has dropped modestly over time; a 2015 Pew survey found 66% of Republicans and 26% of Democrats in favor of fracking, which dropped to 55% and 25%, respectively, in 2016 (Swift, 2016). This sharp partisan divide echoes that observed in other areas of energy policy (Goldfarb et al., 2016), and raises the possibility that public support for fracking is frozen along partisan lines.

However, there is at least some evidence to suggest that Americans' attitudes toward fracking are malleable (Bolsen and Druckman, 2015). For example, using a split-ballot survey Clarke et al. (2015) found that support for hydraulic fracturing varied substantially depending on the words used to identify the process. A greater percentage of Americans supported the energy extraction process when it was described as *shale oil* or *gas development* than when it was called *fracking*. If a simple change in nomenclature can produce significant changes in public support for fracking, then public opinion may also be responsive to arguments about its costs and benefits.

2.1. Partisan heuristics in a context of low information

The extent to which public opinion on fracking will be responsive to policy relevant information should depend in large part on how individuals use partisanship in their decision-making calculus. Past scholarship suggests two possibilities. First, a long literature stemming from considerations of information processing (Kuklinski and Hurley, 1994; Lupia, 1994; Lupia and McCubbins, 1998; Zaller, 1992) has argued that heuristics—cues or cognitive shortcuts—allow the public to make reasonable choices despite lacking relevant information (Mondak, 1993a; Popkin, 1991). Perhaps the most commonly relied on heuristic in American politics is partisanship (Rahn, 1993). Even having little to no information about a candidate or issue, the public can rely on this simple identification to correctly identify candidates that best represent their issue preferences (Lau and Redlawsk, 1997), to process and recall information (Lodge and Hamill, 1986), and generally to form opinions when there is a need for cognitive efficiency to reduce complexity in evaluative processes (Mondak, 1993a, 1993b). If partisanship is simply a heuristic that most Americans use to form their opinions of fracking when they lack direct information on the process and its consequences, then new information may lessen the importance of the partisan cue. Readily accessible information about fracking and its costs and benefits would reduce the need to draw on the partisan heuristic.

Past research on framing theory offers clear expectations (Chong and Druckman, 2007, 2010). Provided that frames are of equal strength, one-sided information flows should produce opinion updating in the direction of the cue. By contrast, in two-sided information flows, in which subjects receive arguments on both sides of the issue, frames of equal strength will cancel each other out and there will be no opinion change. The logic and literature on framing theory generates the following three hypotheses:

H1. Exposing subjects to arguments about the economic benefits of fracking should increase support for fracking.

H2. Exposing subjects to arguments about the environmental costs of fracking should decrease support for fracking.

H3. Simultaneously exposing subjects to arguments about the economic benefits and environmental costs of fracking should not produce any significant change in public support for fracking.

2.2. Partisan motivated reasoning

However, partisanship may be more than a heuristic that allows Americans to form opinions when they lack relevant information. It may instead serve as a perceptual screen through which they assess new information and decide whether or not to incorporate it into their judgments (Campbell et al., 1960; Zaller, 1992; Bartels, 2002). A significant literature suggests that Americans routinely engage in partisan motivated reasoning: they seek out information consistent with their bias, and counter-argue and dismiss evidence inconsistent with their partisan predispositions (Taber and Lodge, 2006; Redlawsk, 2002; Druckman et al., 2013). If most Americans engage in partisan motivated reasoning, then exposure to arguments describing the costs and benefits of fracking is unlikely to lead to uniform opinion change; most will process this information through the lens of their partisan predispositions (Petersen et al., 2013).

Republicans and Democrats may evaluate policy relevant information concerning energy and the environment very differently. For decades, elites from the two parties – particularly elected officials of national stature and major opinion leaders – have taken starkly contrasting positions on the tradeoff between the need to produce more energy and the associated environmental risks (Kamieniecki, 1995; McCright et al., 2014). In controversies ranging from drilling in the Arctic National Wildlife Reserve to the scale and scope of offshore oil drilling, Republicans have consistently championed expanded production over environmental concerns, while Democrats have largely prioritized environmental protection. If anything, the two parties' positions have only grown more polarized over time (McCright and Dunlap, 2011; Rosenbaum, 2014). This polarization is reinforced by the emergence of echo chambers in which partisan elites rely almost exclusively on the same small number of like-minded sources for policy relevant information (Jasny et al., 2015; Farrell, 2015).

With respect to fracking in particular, recent debates have also revealed a partisan divide. Republicans almost universally support fracking and argue that its benefits outweigh any environmental risks. Democratic elites are somewhat more conflicted. Some, such as former chairman of the Senate Committee on Energy and Natural Resources Ron Wyden, mostly support efforts to expand natural gas production; others, such as 2016 presidential candidate and Vermont Senator Bernie Sanders, vehemently oppose it; and still others, including former Secretary of State Hillary Clinton and President Obama, advocate a balanced approach (Goad, 2013; Davenport, 2015; Leber, 2016b). However, even Democratic supporters of fracking have emphasized the need for greater environmental safeguards.⁴ Political elites' reactions to the Interior Department's announcement of new federal regulations on fracking clearly illustrates the partisan divide. The regulations were met by a chorus of criticism from Republican lawmakers and presidential candidates alike (Helman, 2013; Richardson, 2015). By contrast, congressional Democrats responded by introducing new legislation that would put even further restrictions on fracking, including a proposal to close the “Halliburton loophole” that prohibits the EPA from regulating fracking under the Safe Drinking Water Act (Schor, 2015a, 2015b).

If Americans engage in partisan motivated reasoning, then they will

⁴ Moreover, rising opposition to fracking among many Democrats has led even erstwhile supporters of increased natural gas production as a bridge fuel, such as Secretary Clinton, to favor increasingly tough regulations that would all but ban fracking in most areas (Leber, 2016a, 2016b).

interpret and evaluate new information about fracking through the lens of their partisan predispositions. Most importantly, motivated reasoning will encourage people to counter-argue against and dismiss information that challenges their existing partisan-informed predispositions. Past research has found strong evidence that Americans engage in motivated reasoning when evaluating policy relevant information and arguments on a range of energy policy questions from climate change, to nuclear power, to genetically modified food, to nanotechnology (e.g. Druckman and Bolsen, 2011; Hart and Nisbet, 2011; Bolsen et al., 2014b). In the context of public opinion toward fracking, a partisan motivated reasoning perspective suggests the following hypotheses:

H4. Republican support for fracking will increase when exposed to arguments about the economic benefits of fracking. By contrast, such arguments will have little influence on support for fracking among Democrats.

H5. Democratic support for fracking will decrease when exposed to arguments about the environmental costs of fracking. By contrast, such arguments will have little influence on support for fracking among Republicans.

Finally, when confronted with a two-sided information flow in which subjects are exposed to arguments on both sides of an issue, subjects should accept information that is consistent with their partisan orientation and incorporate it into their range of salient considerations. By contrast, subjects should reject arguments that are inconsistent with their partisan orientation and resist incorporating it into the opinion formation process (Zaller, 1992), which generates a clear hypothesis:

H6. When exposed to arguments about both the economic benefits and environmental costs of fracking, Democrats will become more opposed to fracking and Republicans will become more supportive of it.

2.3. When partisanship and policy preferences conflict

Finally, partisanship may be the most important heuristic on which many Americans draw when assessing questions of environmental policy, such as support for fracking. However, it is not the only potentially salient consideration. Given the American public's widespread lack of policy relevant information, opinion scholarship has long downplayed the importance of policy preferences in opinion formation. However, recent studies have argued that in some cases citizens' policy preferences can play a key role in shaping Americans' political assessments (Boudreau and MacKenzie, 2014; Bullock, 2011; Christenson and Kriner, 2016).

The public debate over fracking is linked to larger questions about anthropogenic climate change, on which many Americans hold entrenched beliefs (Weber and Stern, 2011; Aklın and Urpelainen, 2013). For example, a search of Lexis Nexis reveals that between December 1, 2014 and December 1, 2016, just under 1000 newspaper articles combined fracking with a mention of either climate change or global warming.⁵ Policymakers in Washington also repeatedly seek to link (or to deny any linkage between) fracking and climate change. A search of the *Congressional Record* shows that during the last three Congresses (112th–114th), members of the House and Senate gave 145 floor speeches that discussed both fracking and climate change.⁶

As a result, Americans who possess strong preexisting views about global climate change may draw on these views when determining whether or not they support fracking. The existing literature on public support for fracking has not directly examined this relationship. However, data from an August 2014 Pew Research Center poll suggests

⁵ A search of Lexis Nexis' newspapers holdings for "fracking AND 'climate change' OR 'global warming'" during this period returned 992 hits. For linkages between Americans' attitudes toward fracking and their more general environmental policy preferences, see Davis and Fisk (2014).

⁶ This search was conducted on the *Congressional Record* using the website of the Library of Congress and the same search terms as in the search of Lexis Nexis' newspaper holdings.

a very significant linkage. Only 28% of subjects who believed that the Earth was warming as a result of human activity, such as burning fossil fuels, supported the increased use of fracking to bolster natural gas production. By contrast, a strong majority, 59%, of subjects who did not believe in anthropogenic climate change supported fracking. Of course, beliefs about climate change and political partisanship – which also shapes support for fracking – are strongly correlated (Dunlap et al., 2016; Kahan and Corbin, 2016). However, the two factors are not perfectly collinear.⁷ And in this survey, the dramatic split in fracking support among global warming believers and non-believers remains significant when focusing more narrowly on partisan subgroups. Among Democrats, support for fracking was 26% greater among climate change skeptics (50% vs. 24%). Similarly, among Republicans there is a 29% gap, with 69% of climate change skeptics supporting fracking versus just 40% among those who believed in global warming.⁸

This generates our final research question: how does conflict between these partisan and policy heuristics affect information processing? Top-of-the-head models of opinion formation (e.g. Taylor and Fiske, 1978; Zaller and Feldman, 1992) offer clear expectations. On most questions of political interest, many Americans lack strongly held, invariable attitudes. Instead, they draw on the considerations that are most salient at the top of their head at the moment of the survey response. In the context of determining support for or opposition to fracking, partisan affiliation and attitudes toward climate change may be among the most salient considerations on which many Americans can draw. Whether these two main heuristics are in alignment or in conflict may moderate the influence of arguments about the costs or benefits of fracking on opinion formation. When an individual's partisanship and climate change policy preference are in conflict, information about the costs or benefits of fracking may be enough to tilt the balance of considerations at the top of the head in one direction or the other. By contrast, for individuals whose partisanship and policy preferences are aligned, the probability of an argument about costs and/or benefits altering the balance of considerations at the top of their head is lower. As a result, in the analyses that follow we will examine whether exposure to arguments about the costs or benefits of fracking is most influential among subjects with conflicting partisan and policy considerations (e.g. Republicans who believe in government action to address climate change and Democrats who do not believe government should act to address the threat posed by climate change).

3. Methods

3.1. Survey sample

To examine whether Americans' support for fracking is affected by exposure to arguments about its economic and environmental costs and benefits we embedded an experiment within a nationally representative survey fielded between March 7–11, 2016. This internet-based survey was administered by YouGov/Polimetrix, which uses a two-stage sample matching methodology to produce nationally representative results from a large opt-in panel.⁹ To produce our sample, YouGov initially recruited 2124 participants from their panel. Using

⁷ For example, in the 2014 Cooperative Congressional Election Study, 16% of Democrats answered that climate change was not a serious problem requiring government action. Conversely, while 69% of Republicans shared this view, 31% of Republicans disagreed and responded that climate change was indeed an urgent problem requiring government action.

⁸ Pew Research Center, 2014 General Public Science Survey, August 15–25, 2014. The full data set can be downloaded from Pew at: <http://www.pewinternet.org/datasets/2014-science-issues/>. The relevant questions are: support for fracking (Q24C); beliefs in anthropogenic climate change (Q20F1); political partisanship (PARTY and PARTYLN).

⁹ Sample demographics and comparisons to the GSS and U.S. Census data are reported in the Supporting information. For more information on YouGov's sampling strategy, as well as the results of a recent Pew Study showing YouGov outperforming other online competitors, see <https://today.yougov.com/news/2016/05/13/pew-research-yougov/>.

data from the 2010 American Community Survey, this pool was then matched down further to produce a nationally representative sample of 2000 subjects. The larger sample size was necessary to ensure a sufficient number of subjects to test our hypotheses about partisan motivated reasoning and the moderating influence of the interaction of partisanship and policy preferences concerning climate change.

3.2. Experimental design

Subjects were randomly assigned to one of four experimental conditions. All subjects received an initial prompt: “Fracking’ is a way to extract natural gas from shale rock deep underground.”¹⁰ Subjects in the control group received no further information. Subjects in the first treatment group received a prompt informing them of the economic and environmental benefits of hydraulic fracturing: “Supporters of fracking argue that it creates jobs and lowers energy prices for consumers and that burning natural gas is cleaner than burning coal.” By contrast, subjects in the second treatment group received information about the environmental costs of fracking: “Opponents of fracking argue that it contaminates ground water supplies and that burning natural gas, while cleaner than burning coal, is dirtier than producing energy from renewable sources.” Finally, subjects in the third treatment group received both statements, informing them of both sets of arguments about the benefits and costs of fracking. All subjects were then asked to indicate their level of support for or opposition to fracking.

3.3. Variable measurements

The survey measured support for or opposition to fracking on a five-point response scale ranging from “strongly support” to “strongly oppose.” Substantively, the percentage of Americans supporting fracking is the most politically relevant quantity that is most often emphasized in media report and policy debates. As a result, from this question we constructed a binary dependent variable coded 1 for subjects who strongly or somewhat supported fracking and 0 for those who did not. While this operationalization of the dependent variable allows us to focus on the most politically important quantity of interest, in the [Supporting information](#) we present the results of additional analyses using alternate operationalizations of the dependent variable that yield substantively similar results.¹¹

To test our additional hypotheses about motivated reasoning we also asked subjects to indicate their partisan affiliation on an eight-point scale. Following standard practice in political science, we coded strong and weak identifiers, as well as those who leaned toward one party or the other, as partisans ([Petrocik, 2009](#)).¹²

Finally, to test our hypotheses concerning whether arguments about

¹⁰ This initial prompt, and the question with which the experiment concluded were adapted from [Yale \(2012\)](#). The question wording is also identical to that used by [Boudet et al. \(2016\)](#). We use the term “fracking” rather than “hydraulic fracturing” because of its greater popular salience. For example, a simple Google search produces more than twelve million hits for the former, but fewer than a million for the latter. Moreover, a search of the Roper Center for Public Opinion Research’s holdings reveals that many more public survey questions use the term “fracking” than “hydraulic fracturing.” While some surveys use both terms, only one survey used only the more technical term, “hydraulic fracturing.” The complete wording of the experiment is presented in [SI Appendix 1](#) in the [Supporting information](#).

¹¹ Ordered logit regressions (reported in the [Supporting information](#)) using the full five-point response scale yield similar results; however, likelihood ratio tests suggest that the proportional odds assumption is violated. As a result, we also estimate multinomial logit models that show the effects of each factor on subjects either supporting fracking (i.e. answering 5 or 4 on our scale) or opposing fracking (i.e. answering 1 or 2 on our scale), vs. the midpoint category as a baseline (i.e. answering 3 on our scale). As shown in [SI Table 7](#), the results are substantively similar to those presented in the text. The benefits treatment significantly increased the probability of supporting fracking vs. the baseline category of neither supporting nor opposing fracking. However, none of the treatments affected the probability of opposing fracking vs. neither supporting nor opposing. These results led us to focus on the more readily interpretable binary measure of support for fracking in the text. See the [Supporting information](#) for full results and additional discussion.

¹² Treating leaners as independents yields substantively similar results.

the costs and benefits of fracking will be more influential among individuals whose partisanship and environmental policy preferences are in conflict, we included a question to tap subjects’ attitudes toward climate change. To measure these beliefs, we asked a question from [Villar and Krosnick \(2011\)](#): “If nothing is done to reduce global climate change in the future, how serious of a problem do you think it will be?” Responses were coded on a five-point response scale ranging from “extremely serious” to “not serious at all.” Just over 55% of subjects in our sample replied that the threat posed by climate change was “extremely” or “very” serious. We code these subjects as believing that climate change poses a serious threat. Descriptive statistics and complete question wordings for all three variables are reported in [Table 1](#).

3.4. Data analysis

Because subjects were randomly assigned to one of the four experimental groups, the resulting difference in means across conditions are unbiased.¹³ As a result, to test our hypotheses we simply examine the differences in the percentage of subjects supporting fracking the experimental groups. To determine which of the resulting differences in means are statistically significant, we use a one-way ANOVA with a Bonferroni correction to account for the increased risk of Type I error when making multiple statistical tests. The [Supporting information](#) reports the results of a range of additional multivariate analyses that control for additional factors established by the literature to influence attitudes toward fracking. All of these analyses yield substantively similar results.

4. Results

To test our first three hypotheses about the extent to which public support for fracking is responsive to arguments about its costs and benefits, [Fig. 1](#) plots the percentage of subjects supportive of fracking across the three treatment and control groups. Consistent with recent polling surveys ([Borick and Clarke, 2016](#); [Pew, 2015b](#); [Swift, 2016](#)), support for fracking in the aggregate in the control group baseline was low. Just 31% of subjects in this group supported fracking.

Support for fracking was much stronger among those exposed to arguments hailing the economic benefits of fracking. Among those who received the argument of fracking supporters that the process creates jobs, lowers energy prices, and that burning the resulting natural gas is cleaner than burning coal, 42% responded that they supported fracking. An ANOVA with Bonferroni correction confirms that this difference in means is statistically significant ($DM=11\%$; $p < .05$).¹⁴

Thus, the experiment offered strong support for [H1](#) that arguments emphasizing the benefits of fracking would increase public support. By contrast, as shown in [Fig. 1](#) the experiment offered little support for [H2](#). The level of support for fracking in the treatment exposing subjects to arguments emphasizing fracking’s environmental costs, 30%, was just 1% lower than that observed in the control group. This substantively modest difference in means is not statistically significant. Arguments about benefits were able to rally public support for fracking in the aggregate. However, arguments about its costs had no discernible effect on support for fracking.

¹³ To insure that the randomization was successful, we compared the demographic composition of our sample across each of the four experimental groups. Specifically, we examined the following characteristics: Democratic party affiliation; Republican party affiliation; political ideology; educational attainment; age; race; gender; and beliefs about climate change. For each sample characteristic, we conducted a one-way ANOVA. In no case could we reject the null hypothesis of equal means in the sample characteristics across the four experimental groups, $p < .05$. The full demographic balance across groups and all test statistics are reported in the [Supporting information](#).

¹⁴ The difference in means between each experimental group and the relevant p-values are all presented in [SI Table 4](#) in the [Supporting information](#). Throughout the paper we use the conventional threshold of $p < .05$ when referring to statistical significance.

Table 1
Variable measures and descriptive statistics.

Variable	Question	Descriptive Statistics
Fracking support	Based on anything you may have heard or read about fracking, do you...? 5=strongly support it 4=somewhat support it 3=neither support nor oppose it 2=somewhat oppose it 1=strongly oppose it	Mean: 2.93 SD: 1.36 17% – strongly support it 16% – somewhat support it 30% – neither support nor oppose it 15% – somewhat oppose it 21% – strongly oppose it
Climate change serious	If nothing is done to reduce global climate change in the future, how serious of a problem do you think it will be? 1=extremely serious 2=very serious 3=somewhat serious 4=slightly serious 5=not at all serious	Mean: 2.52 SD: 1.47 35% – extremely serious 21% – very serious 18% – moderately serious 10% – slightly serious 17% – not serious at all
Partisanship	Generally speaking, do you think of yourself as a...? 1=strong Democrat 2=not very strong Democrat 3=lean Democrat 4=independent 5=lean Republican 6=not very strong Republican 7=strong Republican 8=Not sure	27% – strong Democrat 13% – not very strong Democrat 8% – lean Democrat 16% – independent 9% – lean Republican 10% – not very strong Republican 13% – strong Republican 5% – not sure

Note: From the fracking support question, we created a dependent variable coded 1 for those who strongly or somewhat support fracking, and 0 otherwise. From the climate change serious question, we created a binary variable coded 1 for those who believe climate change is extremely or very serious and, 0 otherwise. From the partisanship question, we created two indicator variables. The first is coded 1 for those who identified as strong or not very strong Democrats or who leaned toward the Democratic Party, and 0 otherwise. The second is coded 1 for those who identified as strong or not very strong Republicans or who leaned toward the Republican Party, and 0 otherwise.

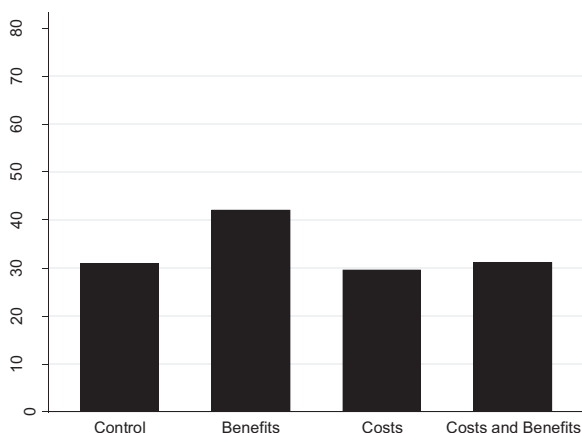


Fig. 1. Support for fracking across experimental groups.

Finally, consistent with H3 we found no evidence that simultaneously presenting subjects with arguments about both the costs and benefits of fracking had any effect on support for fracking. The level of support in this treatment, 31%, is identical to that observed in the control. This is consistent with the hypothesis derived from framing theory (Chong and Druckman, 2007, 2010) that exposing subjects to equally strong frames will cancel out their influence on public opinion.

4.1. Partisan moderation

While we found some evidence that public support for fracking shifts in response to new information in the aggregate, we also hypothesized that not all Americans will respond to information about the costs and benefits of fracking in the same way. Partisanship may serve as an important perceptual screen through which Americans evaluate policy-relevant information in a polarized issue area like fracking. To test our second set of hypotheses, we disaggregated our survey sample by partisan identification. Fig. 2 presents the percentage of subjects supporting fracking in each

experimental condition by partisan affiliation.

Consistent with H4, Republican support for fracking was much higher in the benefits treatment than in the control group baseline, (71% vs. 52%). ANOVA confirms that this 19% difference in means is statistically significant (DM=19%; $p < .05$). By contrast, H4 predicted that Democrats, who have partisan predispositions to oppose fracking, would be less responsive to arguments heralding the benefits of fracking. Strongly consistent with H4, among Democrats the difference in means between the benefits and control groups is much smaller, 28% vs. 20%. ANOVA with the Bonferroni correction reveals that this difference is not statistically significant. This is consistent with many Democrats engaging in motivated reasoning and refusing to incorporate arguments about the benefits of fracking into their assessments of the process.

As in the aggregate, we continue to find little evidence that arguments emphasizing the environmental costs of fracking eroded support for the process even after disaggregating by partisanship. The percentage of Republicans supporting fracking in the costs treatment is

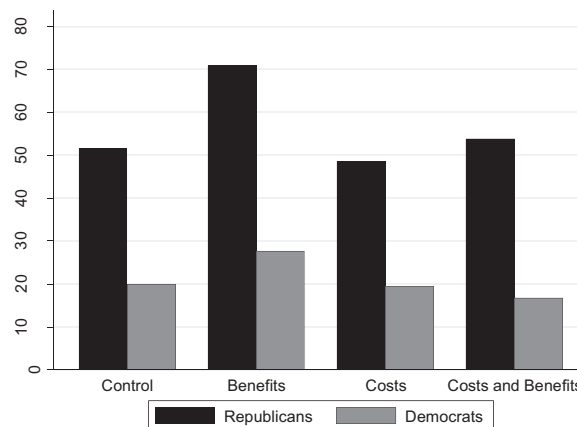


Fig. 2. Support for fracking across experimental groups by partisanship.

slightly lower than in the control (48% vs. 52%). However, ANOVA reveals that the difference is not statistically significant. Among Democrats, support for fracking is less than half a percentage point lower in the costs treatment than in the control group; this very small difference in means is also not statistically significant. While the modest difference in support between the costs treatment and control among Republicans is consistent with expectations from H5, the even smaller difference among Democrats is inconsistent with it.

Finally, H6 suggests a different explanation for the lack of any difference in support between the control and the combined costs and benefits treatment in the aggregate. A motivated reasoning approach suggests that the combined treatment should increase support among Republicans, who accept and incorporate into their opinions arguments about benefits but reject information about the costs of fracking, and decrease it among Democrats, who engage in the opposite cognitive processing. If Democrats and Republicans respond in opposite ways to the same combination of arguments, the arguments may nonetheless be influential within a partisan group, even if the result in the aggregate is no opinion change versus the control. Fig. 2 offers little support for this final hypothesis derived from a motivated reasoning approach. Support for fracking was only 2% higher in the combined costs and benefits treatment than in the control group (54% vs. 52%) among Republicans. Among Democrats, support was only marginally lower in the combined treatment than in the control (17% vs. 20%). Although both differences are in the expected direction, ANOVA shows that neither difference is statistically significant.¹⁵

4.2. Conflicting partisanship and policy beliefs

Finally, we consider our last research question speculating that subjects whose partisan identity conflicts with their personal beliefs about global warming should be particularly susceptible to persuasion. Top of the head models of public opinion formation (e.g. Zaller and Feldman, 1992; Zaller, 1992) suggest that such subjects should be most responsive to new information because it is more likely to tilt the balance of considerations in their minds at the moment of the survey response. By contrast, when partisanship and climate change attitudes are mutually reinforcing, exposure to arguments about the costs or benefits of fracking is unlikely to alter the balance of considerations guiding the survey response. Such arguments either simply reinforce existing partisan and policy considerations, or they are overwhelmed by those consistent partisan and policy priors.

Consistent with this perspective (Fig. 3), among subjects with conflicting partisan and policy predispositions – that is, among Republicans who believed climate change is a serious problem and among Democrats who did not – support for fracking was much higher in the benefits treatment than in the control group (52% vs. 20%).¹⁶ ANOVA confirms that this large difference in means is statistically significant ($DM=32\%$; $p < .05$). By contrast, among subjects whose partisanship and global warming beliefs were aligned, the benefits treatment had only a very modest effect. Fracking was supported by 41% of such subjects in the benefits treatment, versus 36% in the control group. This 5% difference is substantively modest, and it is not statistically significant.

The costs treatment continued to have no statistically significant effect on support for fracking, even among those with conflicting

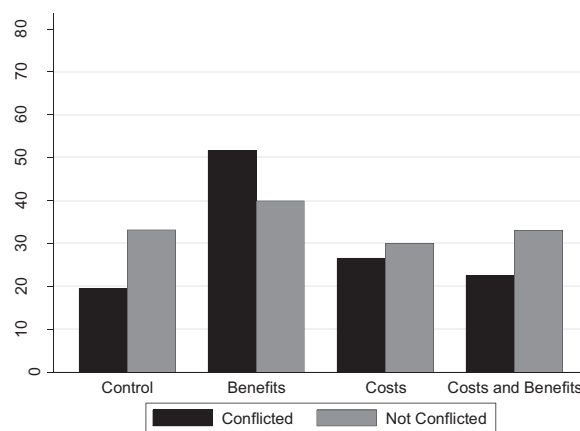


Fig. 3. Support for fracking across experimental groups, conflicted vs. not conflicted.

partisan and policy predispositions. Thus, the experimental evidence is partially consistent with top-of-the-head models emphasizing the presence of conflicting considerations; however, support for fracking was surprisingly resistant to information about its environmental costs across all segments of the sample.

5. Discussion

Consistent with recent research (Boudet et al., 2016) we find evidence of considerable public skepticism toward fracking.¹⁷ However, public opinion has not completely calcified on the issue. Instead, in contrast to other policy areas, we found strong evidence that Americans responded to arguments about the environmental and economic costs and benefits of fracking. Subjects exposed to arguments touting the economic benefits of fracking were significantly more supportive of the process, all else being equal, than were subjects in the control group. However, simultaneously exposing subjects to information about both costs and benefits completely canceled out this positive effect, producing a level of support indistinguishable from that observed in the control. This latter result is both consistent with framing theory and critically important from a policy perspective. Coupled with the low base level of support for fracking observed in the experimental control group and in other recent surveys (e.g. Swift, 2016), our results speak to the power of groups mobilized in opposition to fracking to counteract arguments offered by its proponents.

Finally, providing information about only the costs of fracking had no effect on support for the process. This suggests that the roughly 30% support observed in the control may represent a floor level of support. It may simply be all but impossible to sway this small group of core fracking supporters. An alternate potential explanation for the null effects is the nature of the costs treatment itself.¹⁸ The treatment presented the argument of fracking opponents that the procedure contaminates ground water supplies and that “burning natural gas, while cleaner than burning coal, is dirtier than producing energy from renewable sources.” Because this treatment acknowledged some environmental benefit, perhaps it was seen as a weaker frame than the benefits frame, which did not acknowledge any downsides to the process. To test this alternate hypothesis, we conducted a follow-up survey asking subjects to assess the relative efficacy of arguments about fracking. Subjects were then randomly assigned to evaluate either our benefits or our costs treatment language. In this follow-up

¹⁵ A potential explanation for the limited evidence of partisan motivated reasoning, particularly support for H6, is that motivated reasoning, particularly on an issue like fracking on which many Americans lack basic knowledge, may be concentrated among only the most knowledgeable and politically sophisticated Americans. We explore this possibility in detail in the Supporting information. There we present additional analyses showing evidence consistent with H6, but only among the most highly educated subjects in our sample.

¹⁶ Approximately 18% of Democrats did not believe climate change is a serious problem; by contrast, 24% of Republicans judged climate change a serious problem.

¹⁷ For the sake of comparison, Boudet et al. (2016, 601) observed a mean level of support for fracking of 3.02 on their five-point response scale. In the control group, our survey returned an estimated mean level of support of 2.93 on an almost identically worded question (only the wording of the midpoint answer choice indicating uncertainty differed across the surveys).

¹⁸ We thank an anonymous reviewer for suggesting this additional line of inquiry.

survey, which is described in greater detail in the [Supporting information](#), we found no evidence for this alternate explanation. If anything, subjects judged the costs frame to be slightly stronger, on average, than the benefits frame. As a result, the data is more consistent with a floor effect. Given the staunch support for all forms of expanded domestic energy production in some partisan and ideological circles, support for the process is unlikely to fall much below 30%, no matter how much critics of fracking emphasize its environmental risks.

While the experiment afforded some evidence of partisan moderation, the evidence was mixed. The experiment found strong evidence consistent with [H4](#); arguments about the benefits of fracking increased support among Republicans to a much greater degree than it did among Democrats. The evidence for [H5](#) was conflicting; arguments about the costs of fracking did not decrease support for fracking among Republicans, but it also failed to do so among Democrats. Finally, [H6](#), positing that Democrats and Republicans would respond differently to the combined costs and benefits treatment with each group updating in the direction of the cue consistent with their partisan predisposition, also found little empirical support.¹⁹ These mixed results are somewhat surprising, given recent research in political science showing how partisanship shapes how Americans process a wide range of policy-relevant information (e.g. [Bartels, 2002](#); [Gerber and Huber, 2010](#)). The contrast with strong evidence of partisan motivated reasoning in attitudes toward climate change is also striking (e.g. [Hart and Nisbet, 2011](#); [Kahan, 2013](#)). However, the limited evidence of partisan motivated reasoning in this context echoes research by [Clarke et al. \(2015\)](#), who found no evidence that political ideology moderated the effect of the words used to frame the process (i.e., either as “fracking” or “shale oil or gas development”) on public support for fracking. A floor effect could explain the relatively weak evidence of partisan motivated reasoning, particularly with respect to the costs treatment. With only 20% of Democrats supporting fracking in the control group, there was not much room for arguments about costs to further suppress support for fracking.

Finally, while recent research has shown that attitudes toward global warming continue to polarize along partisan lines (e.g. [Dunlap et al., 2016](#); [Kahan and Corbin, 2016](#)), the two are not perfectly collinear. In our sample, more than 20% of Democrats and Republicans held views on global climate change that diverged from the dominant view of their co-partisan elites. When assessing major questions of energy and environmental policy, this group of Americans draws on two highly salient, but conflicting considerations. Consistent with expectations derived from top-of-the-head models of opinion formation, we found that this group was highly influenced by arguments about the benefits of fracking. However, even in this group we found no evidence that arguments emphasizing the costs of fracking lowered support for the process. By contrast, among those for whom partisan predispositions and climate change beliefs were mutually reinforcing, support for fracking was considerably less malleable.

5.1. Limitations

Our study allowed us to test the malleability of public support for fracking when exposed to arguments about its benefits and costs, as well as the extent to which Americans engage in partisan motivated reasoning when assessing such information. Nevertheless, there are two important limitations of the study that merit discussion. First, our experiment employed a post-test only design. Subjects were randomly assigned to either the control or one of our three treatments, and then all were asked the same question. Each treatment effect is then estimated by comparing levels of support across the treatment and control groups. An alternate approach would be to employ a pre-test/

¹⁹ However, as detailed in the [Supporting information](#), we did find stronger evidence consistent with [H6](#) among the most highly educated subset of our sample.

post-test design in which subjects are first asked their opinion of fracking; then administered a treatment; and then asked the same question about support for fracking a second time. The advantage of our approach is that it guards against anchoring (e.g., [Samuelson and Zeckhauser, 1988](#)), which could be problematic in a single, cross-sectional survey. The disadvantage is that it does not allow us to assess individual-level opinion change in response to receiving a treatment; instead, we compare mean levels of support for fracking across experimental groups. Moreover, a post-test only design relies on randomization being successful and the control and treatment groups not differing systematically in a way that might be driving the observed differences. Our data strongly suggests that randomization was successful; however, we cannot be completely certain that the treatment and control groups do not differ on some unobserved characteristic that might also be correlated with support for fracking.

A second limitation concerns our ability to assess which types of Americans are most responsive to information about the costs and benefits of fracking. Our study allowed us to test hypotheses about motivated reasoning and that individuals with conflicting partisan affiliations and environmental policy beliefs would be more responsive to information about fracking's costs and benefits than subjects whose partisan affiliations and policy beliefs aligned. However, another factor that might moderate the influence of our treatments is subjects' level of prior knowledge about the process. More knowledgeable individuals should draw on a wider range of salient considerations when forming their opinions; as such, the probability of an argument about the costs or benefits of fracking swaying their opinion should be lower for knowledgeable subjects than for less knowledgeable subjects who draw on fewer preexisting considerations.²⁰ Unfortunately, due to space constraints, we were unable to include fracking-specific knowledge questions on the survey. This is an important area for future research.

6. Conclusions and policy implications

The Energy Policy Act of 2005 exempted fracking from regulation under the Safe Drinking Water Act. However, this did not end the political battle over fracking's future. If anything, it multiplied it, as supporters and opponents of fracking mobilized to wage smaller battles at the state and local level ([Warner and Shapiro, 2013](#)). As a result, politicians, think tanks, and government agencies on both sides of the policy divide have debated the relative environmental and economic costs and benefits of fracking with an eye toward winning the debate in the public sphere (e.g. [Dews, 2015](#); [Jackson et al., 2014](#); [Davis, 2012](#)). While a growing literature has explored a range of factors that shape Americans' views of fracking, prior research offers few insights into how Americans will respond to arguments emphasizing its costs and benefits. Our experiment yields direct insight into this important question.

Consistent with a number of recent public opinion polls, we found that only a small minority of Americans supported fracking in our experimental control group (e.g. [Boudet et al., 2014](#); [Pew, 2015b](#); [Borick and Clarke, 2016](#)). However, this low level of support was not entirely calcified. Our results suggest that proponents of fracking have the potential to bolster support for the process by priming Americans to consider its economic benefits and its potential to serve as a bridge fuel that is cleaner burning than coal. However, this potential to build support for fracking comes with an important caveat. If opponents also mobilize and highlight the environmental risks of fracking, they can erase completely the gains made by fracking's proponents. When

²⁰ In the [Supporting information](#), we conduct additional analyses that use education as a proxy for policy-relevant knowledge and political sophistication. There, we find evidence that the effects of the benefits treatment were weaker for the most highly educated subjects in our sample. However, it is important to note that because subjects were randomly assigned across the experimental groups, differences in prior knowledge of fracking should not skew our estimates of the treatment effects.

confronted with arguments on both sides of the policy debate, Americans are not more responsive to one than the other. This translates into a victory for fracking opponents, as public support remains at the low level observed in the control group.

Many policy issues in environmental science are intensely politicized (Bolsen and Druckman, 2015). Moreover, across a range of issues prior scholarship has shown that many Americans engage in partisan motivated reasoning when assessing policy relevant information (e.g. Druckman and Bolsen, 2011; Hart and Nisbet, 2012). Consistent with this dynamic, we found that arguments about the benefits of fracking were more influential with Republicans than they were with Democrats. However, even among Republicans if the arguments of fracking proponents were paired with those of fracking opponents emphasizing its environmental costs, the net effect on support for fracking was essential zero.

Finally, our results suggest that efforts to sway public opinion will be most influential among those whose partisan predispositions conflict with their environmental policy preferences. In our experiment, arguments highlighting the benefits of fracking were much more influential with Republicans who believed in global warming and Democrats who did not than they were with subjects whose partisanship and their policy beliefs aligned. However, given the growing partisan polarization in environmental policy beliefs (e.g. Kahan and Corbin, 2016; Dunlap et al., 2016), our results suggest that the share of persuadable Americans on fracking is quickly dwindling.

On an emerging issue like fracking, public support will be essential to passing new legislation to govern this market. Whether regulations will be included to safeguard the public interest from the costs of fracking, or whether the fracking market will run virtually unregulated, will largely depend on the public's attention to the issue and its awareness of fracking's costs and benefits. During the 2016 campaign, Donald Trump campaigned on a pro-fracking platform; however, in breaking with his party's ranks in Congress, he argued that states and municipalities should also have the authority to block fracking in their communities (Cama, 2016). Since his election, Trump has selected a cabinet full of climate change skeptics, such as his pick for EPA Director, Scott Pruitt, and strong advocates for fossil fuels, such as Secretary of State and former Exxon CEO, Rex Tillerson. These picks for key administration posts, coupled with Republican control of the House and Senate suggest that there will be a big challenge in providing information on the costs of fracking to the general public. Indeed, the outgoing Secretary of the Interior under President Obama, Sally Jewell, used her farewell address to exhort scientists "to fight disinformation" that she feared would be rampant in the next administration (Kaplan, 2016). Our study makes clear that providing information about the environmental costs of different forms of energy production is important to public support.

The natural policy implication of this work, then, is that there is a great and immediate need for the media, climate scientists, and environmentally concerned citizens to ensure that the discussion of fracking consists of a two-sided information flow, where the costs are as clearly communicated as the benefits. Given that fracking is an issue of great importance to a wealthy industry and the chief executive's inner circle, we can expect plenty of special interest pressure and marketing in support of it. The question is therefore simply whether the other side will be heard. If not, we show that individuals of all political stripes will respond positively to arguments emphasizing the benefits of fracking. Moreover, those with conflicted ideological views are especially malleable. On emerging issues, the information game is crucial and the consequences of failure long-lasting.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.enpol.2017.03.002.

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