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The Effects of the Politicization of Science on Public Support for Emergent Technologies

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Abstract

Does the politicization of science influence support for emergent technologies? Can it render appeals to evidence impotent? The authors study these questions by focusing on public support for an emergent energy technology, i.e., nuclear power. Using an experiment embedded within a large survey, they explore how exposure to information that primes the politicization of science affects support for using nuclear power. They find that when individuals are primed to think about the politicization of science, a frame that highlights the environmental benefits of nuclear power, with or without a reference to scientific evidence, is rendered invalid, and support for using it decreases. This is a first attempt to set an agenda of research within political science that focuses on how the politicization of science shapes public opinion toward emergent technologies and trust in science. The results have implications for the future of scientific innovations in today's politicized scientific climate.

A recent statement in the journal *Nature* argued that "there is a growing anti-science streak… that could have tangible societal and political impacts" (2010, 133). That same editorial quoted an example from famed commentator Rush Limbaugh who stated, "Science has become a home for displaced socialists and communists… climate-change science [is] the biggest scam in the history of the world" (133). These are just two examples of a growing number of commentaries on the politicization of science, i.e., when political interests shape the presentation of scientific facts to fit distinct models of "reality" (Nisbet and Mooney 2007; Oreskes and Conway 2010; Pielke 2007, 2004, 2002). A number of studies explore the determinants of trust in sources of scientific information (e.g., see Brewer and Ley 2013), but scant research looks directly at how the politicization of science influences public opinion toward emergent technologies and trust in science. These attitudes clearly matter as the success of any technological initiative ultimately depends on public support from both a political and market perspective (Soss and Schram 2007, 111). We offer what we believe is the first foray into an area of the utmost importance – i.e., how the politicization of science affects public opinion toward novel scientific innovations and trust in science. In addressing this issue, we view ourselves as setting an agenda of research within political science to explore the politicization of science and its effects.

Nuclear Energy

Energy includes traditional sources such as oil, coal, and natural gas (Smith 2002), and alternative sources including nuclear, solar, wind, and hydrogen (Prontera 2009). We focus on nuclear energy, which continues to be considered an "emergent" technology due to continuing developments in its usage (Board on Energy and Environmental Systems 2008). Indeed, interest

has grown recently in the development of nuclear power (e.g., see Bolsen and Cook 2008). An MIT report on the future of nuclear energy explains that "compared to 2003, the motivation to make more use of nuclear power is greater, and more rapid progress is needed in enabling the option of nuclear power expansion to play a role in meeting the global warming challenge (2009, 4)."[1] Nonetheless, public opinion about building nuclear power plants tends to be ambivalent (Ansolabehere and Konisky 2009, 570), which further makes it an intriguing subject to explore. Finally, it is likely that most respondents are at least somewhat familiar with nuclear power (e.g., Gamson and Modigliani 1989; Gamson 1992), unlike other emerging energy technologies (e.g., carbon nanotubes) that have been the subject of previous examinations concerning the dynamics of opinion formation and about which respondents likely possess little or no information (Druckman and Bolsen 2011).

Opinions toward Emergent Technologies

A longstanding theory when it comes to opinion formation about new technologies is the scientific literacy model. This model posits that knowledge facilitates an accurate assessment of the risks and benefits associated with an emergent technology (Nisbet and Goidel 2007; Rodriguez 2007). Despite its widespread acceptance, the scientific literacy model faces at least two hurdles. First, when it comes to public opinion toward emergent technologies, many citizens do not possess the motivation and/or ability to engage in the active processing of evidence and/or the accumulation of scientific knowledge necessary for the model to work. Instead, they often rely on heuristic factors, such as how the technology is framed in a communication, when judging the technology's merits (see Druckman and Bolsen 2011). Second, it has become

[1] In February 2010, the Department of Energy approved financial help for the construction of two nuclear reactors in Georgia, and, if the projects go forward, they would be the first reactors begun since the 1970s.

increasingly difficult to reach consensus in political debates that involve science-based arguments; instead, what often occurs is *politicization* where *political interests shape the presentation of scientific facts to fit different models of "reality"* (Jasanoff 1987, 195; Pielke 2007). Typically this involves non-scientist advocates selectively citing scientific evidence to support their favored political agenda. This leads the public to believe scientific work is colored by political values and beliefs (e.g., Corley, Scheufele and Hu 2009; Lomborg 2001; Pielke 2007). The result is a reduction in the credibility of scientists and the legitimacy of basic research (Pielke 2007, 4-10).[2]

We address two key research questions. First, does politicization render supportive statements about the environmental benefits of an emergent technology invalid, even when the argument includes a reference to scientific evidence? Second, is the impact of a frame highlighting the environmental benefits of nuclear power enhanced by a reference to 3se a consensus among scientists regarding the safe storage and disposal of nuclear waste? We also explore how competitive frames influence opinions without scientific evidence *per se*, a topic that has been well-studied in other settings (see Druckman 2011 for an exhaustive review).

While these topics have not been directly studied, related literatures provide us with some reasons for specific expectations. First, the huge framing literature to which we have referred suggests that frames, all else being constant, should have an effect on individuals' opinions. However, framing effects will *only occur when the frame is sponsored by a credible source* (Druckman 2001). The importance of a credible source is especially relevant when specific evidence is used in conjunction with a supportive frame (O'Keefe 2001, 186). In contrast, if there is a reason to doubt the credibility of a source, then the argument will be rendered mute

[2] The paradigmatic example of politicization is the debate over global warming.

with the consequence that the frame will either have no effect or could even backfire and lead to decreased support for the argument (Lupia and McCubbins 1998; O'Keefe 2001). This negative effect of politicization occurs due to increased uncertainty associated with the credibility of evidence and arguments supported by scientists in a politicized context.

Experiment

We tested the expectations stated above by implementing an experiment in the context of a survey in August 2010.[3] We used the Internet to draw a sample that was representative of the U.S. population.[4] A total of 1,600 individuals took part in the study. Participants began by completing an initial battery of questions that measured attitudes toward various energy sources, laws, and technologies. This was followed by a series of questions measuring values, knowledge, political affiliation, and other individual-level control variables. Next, respondents were exposed to one of the experimental treatments (described below). All participants were informed, "We are now going to ask you about an alternative energy source – nuclear power." This is the only

[3] This was prior to the Fukushima Accident in Japan which occurred on March 11, 2011. Specifically, an earthquake and tsunami in Japan lead to significant damage to several nuclear reactors, releasing radiation levels rivaling the disaster at Chernobyl. Media coverage was extensive. Basic public opinion polls in the U.S. showed a notable decline in support for nuclear energy. This is problematic for energy policy given the renewed commitment to nuclear energy. This is relevant for us given that all of the data reported above was collected prior to this event. However, we expect the accident at Fukushima only to affect overall support for nuclear energy and not to condition the causal impact of the experimental conditions .We conducted a lab experiment analogous to our main study using a sample of undergraduate students to confirm that the treatment effects remained unchanged after the earthquake. Results available upon request from the authors show that the overall causal effects resulting from exposure to the experimental conditions are roughly the same, but, as expected, overall support for using nuclear energy dropped by about 6% across conditions.

[4] The survey was funded through a grant from the Institute for Sustainability at Northwestern (ISEN). We contracted with a survey research company (Bovitz Inc.) to collect the data. The sample was drawn from a panel of respondents who have opted in to complete online surveys. The panel was originally developed based on a random-digit-dial (RDD) telephone survey, where to enter the panel a respondent needed to have access to the Internet (In this sense, it is a non-probability sample in the same way as those taken by firms such as YouGov are non-probability samples). The panel has continued to grow based on ongoing RDD recruiting and referrals. From the panel, which has approximately 1 million members, a given sample is drawn using a matching algorithm (based on likely response rates) to ensure that those screened to qualify for the survey constitute a sample that demographically represents the United States.

information that individuals who were randomly assigned to a control group received. Respondents in the control condition were then presented with our primary dependent measure, which asked, "Given what you know, to what extent do you oppose or support the use of nuclear energy as one of the ways to provide electricity for the U.S.?" on a 1 to 7-point fully labeled scale ranging from 1 = "strongly opposed" to 7 = "strongly support."[5] All other participants were randomly assigned one of eight other experimental conditions in which two distinct dimensions of considerations were manipulated.

Priming Manipulation

We randomly assigned participants to one of three priming conditions: no prime (in which case, no information was added to the initial statement), a politicization prime, or a science benefit prime. There are many ways one could operationalize the construct of politicization. For instance, one approach might involve competing speakers presenting scientific evidence on opposing sides of an issue. However, while this might prime politicization, it might also prime partisan polarization more generally. While alternative priming strategies should be explored in future work, we opted not to conflate politicization of science with the partisan polarization of politics *per se* and simply primed politicization directly. Participants randomly assigned to a condition with a politicization prime were told, "We are now going to ask you about an alternative energy source – nuclear power. The development of alternative energies, such as nuclear energy, relies on scientific progress. Yet, it is increasingly difficult for non-experts to evaluate science – politicians and others often color scientific work and advocate selective science to favor their agendas." We pre-tested this treatment on approximately 100

[5] This is a standard question used by Gallup.

respondents from a different sample and found that this prime generated significantly lower trust in science and decreased optimism toward science.

The flip side of a politicization prime might include highlighting science as a way to obtain "truth" through systematic observation and documentation. We thus thought it was important to provide what we view as largely the inverse of the politicization prime by having a "science benefits" prime that emphasized how science can be a path to knowledge.[6] Participants randomly assigned to a condition with a science benefit prime were told, "We are now going to ask you about an alternative energy source – nuclear power. The development of alternative energies, such as nuclear energy, relies on scientific progress. Indeed, scientific research involves the systematic gathering of observable, measurable, and replicable evidence – as such, it provides a relatively objective and unbiased basis for new innovations." We also pre-tested this prime on approximately 100 respondents from a different sample and found that it generated increased trust in science and led to greater optimism toward science.

Framing Manipulation

Our other key manipulation included the presence of a supportive frame that sometimes included a reference to evidence supported by a consensus of scientists. By "frame," we mean a point of emphasis in a communication – a common usage of the term in much of the social sciences (e.g., see Druckman 2011; Nelson et al. 1997). We randomly assigned participants to one of three frame conditions: no frame, a supportive frame highlighting the environmental benefits of nuclear power, and a condition that included related evidence supported by a

[6]We call it a "science benefits" prime simply because it emphasizes the ideal virtues of science, but we acknowledge the name is awfully generic and the construct could be operationalized in different ways as with our politicization operationalization; again, as a first foray in this area, we found our approach most compelling. Also, note that our usage of the term prime does not necessarily mean we think it is not a conscious process; for an extended discussion, see Druckman, Kuklinski, and Sigelman (2009).

consensus of scientists in addition to the supportive environmental frame. We chose a frame that focuses on the environmental consequences of using nuclear energy. We acknowledge the existence of alternative frames associated with nuclear power, such as the potential health risks and effects on energy independence (Gamson and Modigliani 1989), but we chose to highlight the environmental benefits of nuclear energy because, by many accounts, it is the most salient dimension right now on this issue (e.g., Ansolabehere and Konisky 2009). Indeed proponents of nuclear power advance the notion that it produces virtually no air pollution in contrast to the chief viable alternative of burning fossil fuels (Ansolabehere and Konisky 2009, 573-574).

We incorporate the environmental frame with *or* without evidence because one of the major tenets of the aforementioned scientific literacy model is that the presentation of factual evidence should generate increased support for new technologies (for an innovative study on scientific consensus and its effects, see Kahan et al. 2012). Thus, we also randomly assigned respondents to some conditions where the frame included no such evidence or included an explicit statement to a consensus study by the National Academy of Sciences. The former statement added, "Along these lines, many have pointed to research that suggests alternative energy sources (e.g., nuclear energy) can dramatically improve the environment, relative to fossil fuels like coal and oil that release greenhouse gases and cause pollution. For example, unlike fossil fuels, wastes from nuclear energy are not released into the environment." The latter added (in addition), "…A recent National Academy of Sciences publication states, 'A general scientific and technical consensus exists that deep geologic disposal can provide predictable and effective long-term isolation of nuclear wastes'" (Board on Energy and Environmental Systems 2008).[7]

[7] We recognize that many respondents may not realize that the job of the National Academy of Sciences as a non-profit, independent organization entails offering consensus advice on science, technology, and medicine, based on

Table 1 displays the nine experimental conditions to which participants were randomly assigned, as well as our expectations previously stated regarding the impact of each condition on support for nuclear power. The complete wording of the experimental treatment for each condition is reported in Appendix 1. (*Note that we anticipate placing all appendices on-line.*)

[Table 1 About Here]

As intimated, we expect any reference to the benefits of science, regardless of the environmental frame with or without evidence, should increase support for nuclear power given that it is stated that development of nuclear energy depends on scientific progress. In contrast, we expect any reference to politicization to decrease support as it will lead people to lose faith in the credibility of science. They will come to believe science is simply being used in a political battle, as expressed in our opening quote. This will reduce the credibility of any statement in support of a novel technology and may lead it to backfire and decrease support for its use (Lupia and McCubbins 1998). Nonetheless, this decrease may be stunted when supportive information is provided, and especially when evidence appears with it; but even in those cases, we expect respondents to give minimal weight to consensus evidence when told that the evidence may stem from politics and not science *per se*. We expect an increase in support for the use of nuclear power when the positive environmental consequences are emphasized with or without a reference to a scientific consensus regarding related evidence in the absence of a politicization or science benefits prime, thereby echoing the large framing literature (e.g., Druckman 2011).[8]

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expert panels. Thus, any effect could stem from a full understanding that the National Academy does provide consensus evidence or it could be simply seen as a credible source cue.

[8] As a manipulation check, we asked participants, "To what extent do you think political considerations affect the nature of information the public receives about different policies?" on a 7-point fully labeled scale ranging from 1 = "not at all" to 7 = "always." Participants randomly assigned to the politicization conditions reported significantly higher scores on this question.

Results

In presenting the results, we focus on how each experimental condition affects support for using nuclear energy to generate electricity in the U.S. relative to our control group baseline (no frame, no prime, condition 1, Table 1). Figure 1 displays the percentage shift in support for nuclear energy for each condition, relative to the control group where the mean support for nuclear power is 4.46 (std. dev. = 1.78; N = 178); across conditions, the mean support for nuclear power is 4.56 (std. dev. = 1.86; N = 1600). The mean for each condition is listed in Table A-1 in Appendix 2. While we confirmed the success of random assignment, we nonetheless present analyses in Table A-2 in Appendix 3 that show the robustness of all main treatment effects reported below with the inclusion of a host of control variables.

[Figure 1 About Here]

The first finding of note is that the environmental benefit frame, with or without evidence, increases support for nuclear power (conditions 2 and 3, Figure 1). This is consistent with the aforementioned framing literature. Second, simply priming the benefits of science has no effect (condition 4, Figure 1). However, once one adds a statement regarding the environmental benefits of nuclear power, individuals give more credence to that prime and it significantly increases support by over 6% (condition 5, Figure 1). The addition of evidence supported by a consensus of scientists to the science prime and pro environmental frame increases support by over 10% (condition 6, Figure 1). Finally, politicization lowers support for nuclear power, by itself (condition 7, Figure 1) or when paired with an environmental benefits frame (condition 8, Figure 1) and the inclusion of evidence supported by a consensus of scientists accompanying that frame (condition 9, Figure 1) (-4.16% in condition 7, -3.43% in condition 8, and -3.95% in condition 9). This finding has implications for the present state of

political battles over science. These battles - which now seem to extend well beyond the issue of climate change to scientific advances of all stripes - can work to undermine the support that scientific evidence can have on public opinion, thereby making it unlikely that politicians will advocate emergent technologies and/or that consumers will adopt them. Perhaps some will be surprised that adding scientific evidence to a frame that highlights the environmental benefits of nuclear power does not overcome the politicization prime, but, as explained, we suspect politicization causes people to lose faith in any reference to science-based arguments and become risk averse to new innovations, thereby making the scientific literacy model impotent. To summarize, an environmental benefits frame with or without consensually supported scientific evidence only marginally increases support for an emergent technology unless the benefits of science are highlighted. If, in contrast, the politicization of science is highlighted, not only does the frame and evidence have no effect but overall support drops significantly.[9]

Secondary Evidence

One potential concern about our study may be that we focused on generating support for nuclear energy as exemplified in our positive (environmental) frame and in the evidence presented with the frame. We opted for an asymmetric approach for three reasons: to keep the number of conditions reasonable, because it is consistent with the thrust of the scientific literacy approach, and because evidence often accumulates in an asymmetric direction. However, we recognize limitations to this approach, particularly the potential limitation to general inferences due to the noted asymmetry. For this reason, we implemented another study where we used a

[9] We also asked a series of belief importance questions, e.g., in thinking about nuclear energy, how important are the effects of nuclear energy on the environment or human health, and belief content questions that asked about if nuclear energy would have positive or negative effects on these dimensions. As expected from the framing literature (e.g., Druckman 2011), our results largely replicate what is presented in Figure 1 when it comes to the importance of the environment and the environmental benefit frame is invoked. We do not explore mediation given our design precludes such exploration (see Bullock and Ha 2011).

similar design but used a frame that highlighted the potentially negative health consequences of nuclear power rather than the positive environmental benefits. The politicization and science benefits primes were worded the same, but the negative health frame stated that "research suggests that alternative energy sources can sometimes raise health concerns, to an even greater extent than those that result from the polluting gases released by fossil fuels like coal and oil. For example, nuclear power plants sometimes release small amounts of low level radioactive materials that are potentially harmful." Meanwhile, the scientific evidence treatment added, "A recent National Academy of Sciences report explains that the risk of cancer proceeds in a linear fashion and the smallest dose [of radiation] has the potential to cause a small increase in risk to humans" (Board on Radiation Effects Research 2006, 7). We find some evidence that the negative health effects frame with or without evidence decreases support for nuclear power. The results from this experiment are discussed in Appendix 4.

A second question concerns the duration of these effects and whether politicization affects attitudes toward a different emergent technology not evaluated in the initial study. Participants in our first study completed a follow-up survey two weeks after the original treatment, which enables us to address this issue. In this follow-up, we asked three main questions: first, support for carbon nanotubes (ranging from 1 = "strongly oppose" to 7 = "strongly support"); second, trust in policymakers when it comes to introducing new energy technologies (ranging from 1 = "not at all" to 7 = "complete trust"); and, third, trust in scientists' decisions when it comes to introducing new technologies (ranging from 1 = "not at all" to 7 = "complete trust"). In every case, those in the politicization conditions registered significantly lower scores on each of these measures relative to a control group (by 10%, 14%, and 13%,

respectively).[10] We also conducted a follow-up on our health frame (negative) study and found the initial results maintained among those responding to the follow-up request (about 80%; virtually everyone responded in the aforementioned follow-up). Trust in science remained significantly lower among individuals randomly assigned to the politicization prime two weeks later by about 11%.

A final issue concerns trust in science in general as a moderator of science-based communications. One may expect that those who expressed prior trust in science to be affected to a greater extent by pro science prime and consensus scientific evidence, and, indeed, this is what we find. However, we also find that when individuals are exposed to arguments that politicize science even those who are generally trusting of science are skeptical of a frame highlighting the environmental benefits of nuclear power, even when the frame is presented with factual evidence. This is because politicization decreases trust in science and causes people to question the information with which they are presented (i.e., even if they trust science, can they trust this particular piece of evidence?). On the flip side, those initially reporting lower levels of trust in science only increase support for nuclear power when provided with a science benefits prime, an environmental benefits frame, and evidence regarding a scientific consensus regarding safe storage and disposal of nuclear waste, and decreased support universally when exposed to the politicization prime. All of these results are presented in Appendix 5**.**

Conclusion

A central take-away point is that the politicization of science has implications for public support for emergent energy innovations, even among those who trust science. The counter-factual of emphasizing the virtues of science can vitiate that effect but we fear such emphasis is

[10] More specific details concerning these analyses are available from the authors.

less likely in the current political environment. We see our study as an initial one, as much more is to be done such as operationalizing politicization in various different ways with distinct technologies. The growing politicization of science seems to have the potential to have widespread and troubling societal and political implications. Yet this does not mean all is lost. Indeed, Lupia (2012) offers a variety of intriguing prescriptions for how science can be better communicated in a politicized environment, and we see this avenue of research as a critical way forward. Energy politics is inherently a political process, however, politicization has received virtually no attention within political science, and we believe our results demonstrate the importance of a research agenda exploring this topic.

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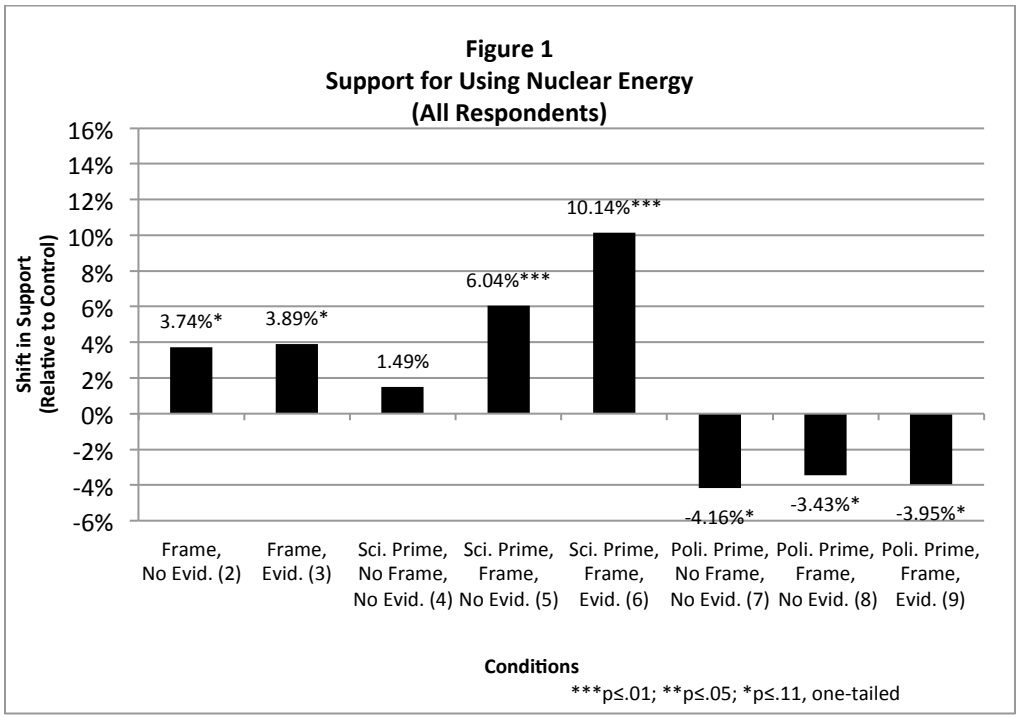
Table 1: Experimental Conditions and Predictions

	No Prime	**Science benefits**	**Politicization**
No Environmental Frame	Condition1 Baseline	Condition 4 Increase Support	Condition 7 Decrease Support
Environmental Frame without evidence	Condition 2 Increase Support	Condition 5 Increase Support	Condition 8 No effect or small decrease
Environmental Frame with evidence	Condition 3 Increase in Support	Condition 6 Largest Increase in Support	Condition 9 No effect or small decrease



Appendix 1 Experimental Wording

Condition 1 No Frame / No Prime
We are now going to ask you about an alternative energy source – nuclear power.

Condition 2 Frame without evidence / No Prime
We are now going to ask you about an alternative energy source – nuclear power. Many have pointed to research that suggests alternative energy sources (e.g., nuclear energy) can dramatically improve the environment, relative to fossil fuels like coal and oil that release greenhouse gases and cause pollution. For example, unlike fossil fuels, wastes from nuclear energy are not released into the environment.

Condition 3 Frame with evidence / No Prime
We are now going to ask you about an alternative energy source – nuclear power. Many have pointed to research that suggests alternative energy sources (e.g., nuclear energy) can dramatically improve the environment, relative to fossil fuels like coal and oil that release greenhouse gases and cause pollution. For example, unlike fossil fuels, wastes from nuclear energy are not released into the environment. A recent National Academy of Sciences publication states, "A general scientific and technical consensus exists that deep geologic disposal can provide predictable and effective long-term isolation of nuclear wastes."

Condition 4 No Frame / Science benefits prime
We are now going to ask you about an alternative energy source – nuclear power. The development of alternative energies, such as nuclear energy, relies on scientific progress. Indeed, scientific research involves the systematic gathering of observable, measurable, and replicable evidence – as such, it provides a relatively objective and unbiased basis for new innovations.

Condition 5 Frame without evidence / Science benefits prime
We are now going to ask you about an alternative energy source – nuclear power. The development of alternative energies, such as nuclear energy, relies on scientific progress. Indeed, scientific research involves the systematic gathering of observable, measurable, and replicable evidence – as such, it provides a relatively objective and unbiased basis for new innovations. Along these lines, many have pointed to research that suggests alternative energy sources (e.g., nuclear energy) can dramatically improve the environment, relative to fossil fuels like coal and oil that release greenhouse gases and cause pollution. For example, unlike fossil fuels, wastes from nuclear energy are not released into the environment.

Condition 6 Frame with evidence / Science benefits prime
We are now going to ask you about an alternative energy source – nuclear power. The development of alternative energies, such as nuclear energy, relies on scientific progress. Indeed, scientific research involves the systematic gathering of observable, measurable, and replicable evidence – as such, it provides a relatively objective and unbiased basis for new innovations. Along these lines, many have pointed to research that suggests alternative energy sources (e.g., nuclear energy) can dramatically improve the environment, relative to fossil fuels like coal and oil that release greenhouse gases and cause pollution. For example, unlike fossil fuels, wastes

from nuclear energy are not released into the environment. A recent National Academy of Sciences publication states, “A general scientific and technical consensus exists that deep geologic disposal can provide predictable and effective long-term isolation of nuclear wastes.”

Condition 7 No Frame / Politicization prime
We are now going to ask you about an alternative energy source – nuclear power. The development of alternative energies, such as nuclear energy, relies on scientific progress. Yet, it is increasingly difficult for non-experts to evaluate science – politicians and others often color scientific work and advocate selective science to favor their agendas.

Condition 8 Frame without evidence / Politicization prime
We are now going to ask you about an alternative energy source – nuclear power. The development of alternative energies, such as nuclear energy, relies on scientific progress. Yet, it is increasingly difficult for non-experts to evaluate science – politicians and others often color scientific work and advocate selective science to favor their agendas. Even so, many have pointed to research that suggests alternative energy sources (e.g., nuclear energy) can dramatically improve the environment, relative to fossil fuels like coal and oil that release greenhouse gases and cause pollution. For example, unlike fossil fuels, wastes from nuclear energy are not released into the environment.

Condition 9 Frame with evidence / Politicization prime
We are now going to ask you about an alternative energy source – nuclear power. The development of alternative energies, such as nuclear energy, relies on scientific progress. Yet, it is increasingly difficult for non-experts to evaluate science – politicians and others often color scientific work and advocate selective science to favor their agendas. Even so, many have pointed to research that suggests alternative energy sources (e.g., nuclear energy) can dramatically improve the environment, relative to fossil fuels like coal and oil that release greenhouse gases and cause pollution. For example, unlike fossil fuels, wastes from nuclear energy are not released into the environment. A recent National Academy of Sciences publication states, “A general scientific and technical consensus exists that deep geologic disposal can provide predictable and effective long-term isolation of nuclear wastes.”

Appendix 2

Table A-1: Experimental Means (Standard Deviations, Ns) By Condition

	No Prime	**Science benefits**	**Politicization**
No Environmental Frame	Condition 1 4.46 (1.78, 178)	Condition 4 4.56 (1.80, 177)	Condition 7 4.16 (1.90, 177)
Environmental Frame without evidence	Condition 2 4.72 (1.90, 180)	Condition 5 4.88 (1.81, 180)	Condition 8 4.22 (1.87, 177)
Environmental Frame with evidence	Condition 3 4.73 (2.03, 176)	Condition 6 5.17 (1.45, 176)	Condition 9 4.18 (1.98, 179)

Appendix 3 Regressions with Controls

We assessed the robustness of our main treatment effects by adding a host of variables correlated with support for using nuclear energy including: *gender* (male = 0; female = 1); *minority status* (minority = 0; non-minority/white = 1); *age* (average of 44.76); *education* (5-point scale from less than high school to advanced degree); *income* (five-point scale from less than $30k to over $200k); *partisanship* (7-point scale from strong Democrat to strong Republican); *trust in government* (4-point scale from never to just about always); *home ownership* (1= yes; 2 = no); and, *pay utilities* (1 = yes; 1 = no) (e.g., Ansolabehere and Konisky 2009). We also measured *ideology* on a 7-point scale from strong liberal to strong conservative, and values, building on Kahan's (2012) *hierarchism* (from low to high on a 7-point scale) and *individualism* (from low to high on a 7-point scale), as well as a general value on a 7-point scale in favor of prioritizing the *economy over the environment* (higher scores indicate greater support for prioritizing the economy over the environment). Finally, we include measures for *media exposure* (standardized 0 to 1 score of newspaper, television news, online news exposure), *political knowledge* (standardized 0 to 1 number of correct answers to four standard political knowledge questions), *scientific knowledge* (standardized 0 to 1 score of number of correct answers to two standard science questions), and *energy knowledge* (standardized 0 to 1 score of number of correct answers to three factual energy questions) with the expectation that increased knowledge may increase support for nuclear energy technologies a la the scientific literacy model, and that media exposure may have an effect given recent attention to more usage of nuclear energy (at the time of the study, it was part of the recent energy bill and, as mentioned, prior to the Fukushima Accident in Japan). Finally, we include a measure for general *trust in science* since those who are more trusting should be more supportive of pro science primes and evidence (standardized on a 0-1 scale with higher scores indicating greater trust).

Table A-2 (below) reports the results from a basic ordered probit model estimating support for our main dependent variable (support for nuclear power) with a dummy variable for each condition, and where the excluded condition is the control group (no prime, no frame, condition 1). There are several control variables that are significant, and not surprisingly so given the existing correlational evidence, such as decreased support for developing nuclear power among females and minorities, and increased support among older and more educated individuals. On the other hand there are several other control variables in which the impacts are more intriguing. For instance, Republicans tend to be more supportive of nuclear power, which presumably reflects values associated with the potential economic gains associated with the technology's development. When it comes to values, individualists (anti-communitarians) are more supportive of nuclear power, which coheres with Kahan's theory that individualists will be more trusting of new technologies and less worried about environmental and technological risks. We also find that participants who prioritize the economy over the environment are more supportive of nuclear power, reflecting a focus on prioritizing gains associated with using nuclear power over concern about the environment. Media exposure increases support as well, perhaps due to the aforementioned relatively positive media coverage in the period prior to when our survey was administered; political knowledge and scientific knowledge increase support too which is to be expected as more knowledgeable individuals have more familiarity with novel technologies. Finally, trust in science increases support for the development of nuclear power. In the end, our experimental conditions remain significant as shown in Figure 1. Indeed, the effects remain largely unchanged with the one exception being the politicization prime with no

environmental benefits frame (condition 7) is no longer marginally significant. Overall, though, it is safe to say that adding controls does not significantly alter our substantive findings.

Table A-2. Determinants of Support for Action

	Exp. Conditions Only	Exp. Conditions With Controls
Environmental Frame Without Evidence (*Condition 2*)	0.16* (0.11)	0.18* (0.11)
Environmental Frame With Evidence (*Condition 3*)	0.17* (0.11)	0.20** (0.11)
Science Prime *(Condition 4)*	0.06 (0.11)	0.10 (0.11)
Science Prime and Environmental Frame Without Evidence (*Condition 5*)	0.24** (0.11)	0.30*** (0.11)
Science Prime and Environmental Frame With Evidence (*Condition 6*)	0.40*** (0.11)	0.48*** (0.11)
Politicization Prime (*Condition 7*)	-0.14* (0.11)	-0.09 (0.11)
Politicization Prime and Environmental Frame Without Evidence (*Condition 8*)	-0.14* (0.11)	-0.16* (0.11)
Politicization Prime and Environmental Frame With Evidence (*Condition 9*)	-0.15* (0.11)	-0.18* (0.11)
Female		-0.28*** (0.06)
Minority		-0.12** (0.06)
Age		0.003* (0.001)
Education		0.07** (0.03)
Income		0.01 (0.03)
Republican		0.03* (0.02)
Trust in Government		0.04 (0.04)
Live in House		-0.02 (0.06)
Pay Utility		-0.01 (0.09)
Ideology		0.01 (0.02)
Hierchalism		0.01 (0.02)
Individualism		0.04** (0.02)

Economy Valued Over Environment		0.11*** (0.02)
Media Exposure		0.22** (0.11)
Political Knowledge		0.32*** (0.10)
Energy Knowledge		-0.01 (0.11)
Scientific Knowledge		0.31*** (0.09)
Trust in Science		1.78*** (0.18)
Cut-Points:	See Below	See Below
Log-likelihood	-2991.2547	-2816.9012
Number of observations	1600	1600

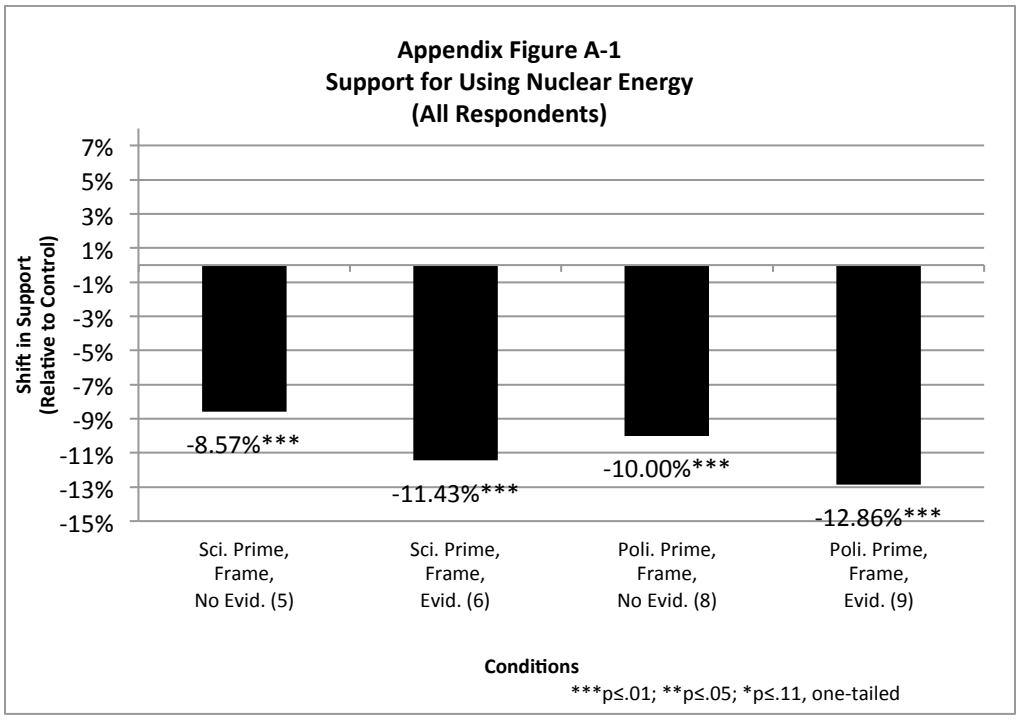
[a]Entries are ordered probit coefficients with standard errors in parentheses.
*** $p \leq .01$; ** $p \leq .05$; * $p \leq .10$ (one-tailed tests). The coefficients and standard errors for cut points 1 through 6 for Model 1 are: -1.29 (0.09), -0.94 (0.08), -0.56 (0.08), -0.002 (0.08), 0.42 (0.08), 0.96 (0.08). The coefficients and standard errors for cut points 1 through 6 for Model 2 are: 1.24 (0.29), 1.61 (0.28), 2.02 (0.28), 2.64 (0.29), 3.13 (0.29), 3.75 (0.29).

Appendix 4: Con Health Frame Experiment

We implemented an experiment with a design analogous to our main study with the difference being the use of a negative frame emphasizing potential health hazards of nuclear energy, and evidence of such health hazards from another National Academy of Sciences (2008) report. Given the results of our main study, we limited this study to five conditions, including the baseline (N = 165), science benefits prime with the negative health frame (N = 118), science benefit prime with the negative health frame and evidence (N = 109), politicization with the health frame (N = 192), and politicization with the health frame and evidence (N = 123). We did this to ensure a sufficient sample size and because the point was to see if politicization and the science benefits primes have analogous effects even when the frame/evidence is negative. See the text above for details on the wording for each treatment.)

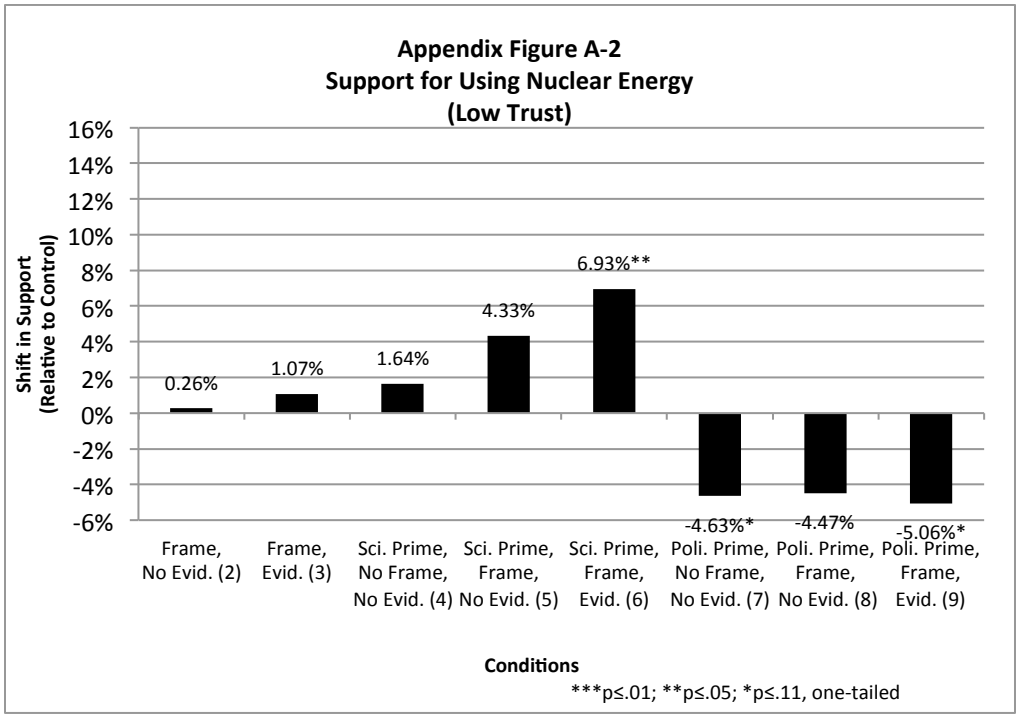
The study was part of an exit poll on Election Day 2010 where a team of 25 pollsters handed out anonymous self-administered surveys to voters departing the polling stations at random voting locations throughout Illinois' 9th district. Pollsters offered respondents a $5 gift card as compensation for filling out a survey on political opinions for an academic research project. Participants were randomly assigned to one of the five conditions just mentioned. Each survey was randomized across polling sites, so the conditions were not correlated with the polling locations. In total, 707 individuals completed the survey at a response rate of 70%.

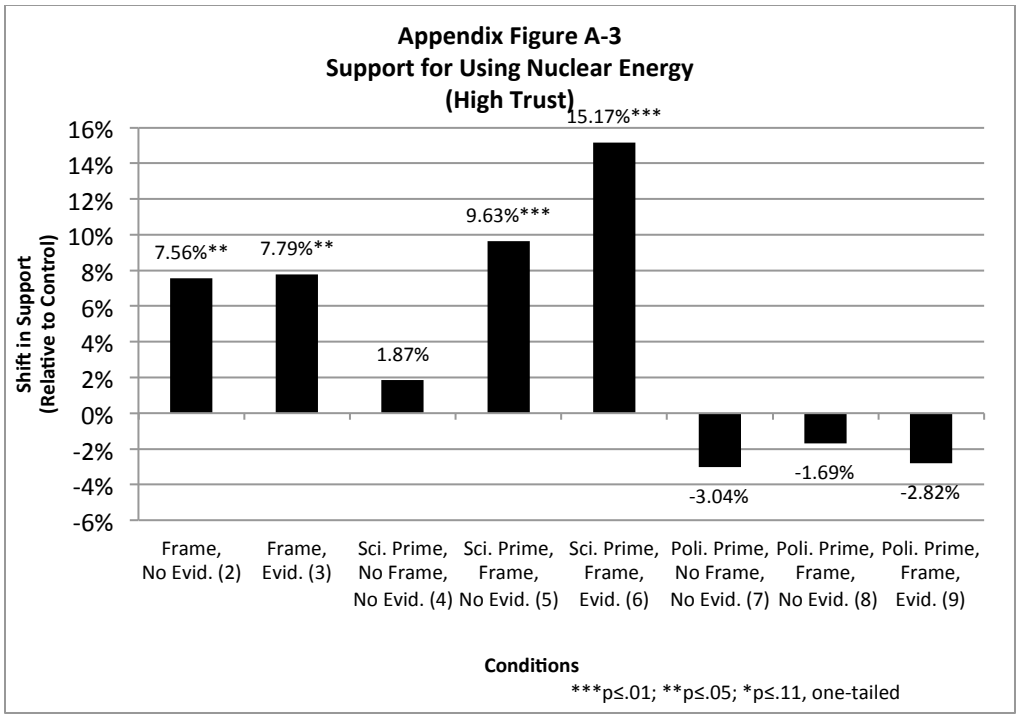
The results displayed in the below figure (Appendix Figure A-1) show that politicization does not appear to counteract a negative frame with or without evidence that highlights concern about the risks of an emergent technology; this may stem from a negativity bias in the opinion formation process. The scientific benefit prime has an impact analogous to what we found above although, as expected, opinions move in the opposite direction given the negative frames and evidence.



Appendix 5: Trust results

Table A-2 in Appendix 3 shows that trust in science is predictive of support for nuclear energy. We also anticipate that trust in science may moderate the impact of the primes and frames, since they invoke science-based arguments. Those more predisposed to trust science may be more accepting of the science prime. In contrast, the politicization prime reminds people of the selective use of science and even those who trust science may be suspicious of its particular usage in rhetoric. Politicization is not about science as being positive or negative *per se* but about its application in making arguments. Those trusting of science may not think of politicization when they hear scientific invoked in an argument, but when primed to think about politicization, they may not know what to believe. Figure A-2 and A-3 (below) present two illustrations of the treatment effects, one for the low trust group and one for the high trust group, separately. We used a median split to divide the groups as is often done (e.g., Miller and Krosnick 2000). (The median split is .51 on a 0 to 1 scale.)





The results show that the environmental benefits frame and the frame with scientific evidence has no effect among individuals with lower levels of trust in science (conditions 2 and 3, Figure A-2); however, there is a substantial treatment effect among individuals with higher levels of trust in science (conditions 2 and 3, Figure A-3). Thus, as we expected, it is not necessary to remind individuals with a high level of trust in science that "science is worthwhile." In contrast, individuals with lower levels of trust in science need a prime reminding them of the benefits of science to have any faith in frames highlighting a scientific consensus with or without supportive evidence. In fact, the only way to generate significant support among individuals lacking trust in science is by adding the science benefit prime, the environmental benefits frame, and the consensual scientific evidence (leading to a 6.93% increase in support). Otherwise, the lack of faith in science presumably stunts movement. In contrast, individuals with relatively high levels of trust in science show substantial movement when given the science benefits prime and the environmental benefits frame with or without evidence. Note that although the science prime by itself does nothing, apparently, the science prime makes the frames more compelling with presented together. In short, the science prime has the added effect among trusting individuals to make the evidence more impactful (see conditions 5 and 6, Figure A-3).

Politicization on its own or appearing with a supportive frames and/ or evidence largely decreases support among low trust respondents and nullifies any changes - even with the frame and consensual evidence - among high trust respondents. As we expected, politicization can void support for an innovation because it causes people – even those who trust science – to be confused about who they can and cannot believe in any specific instance. Note that the differences between groups are significant when we estimate the treatment effects with a regression which includes interactions between each experimental condition and our trust measure. Further, we confirmed that all the main treatment effects are robust with multivariate regressions using the same control variables as listed in Appendix 3.