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Trust in Scientists on Climate Change and Vaccines

Lawrence C. Hamilton[1], Joel Hartter[2], and Kei Saito[1]

Abstract

On climate change and other topics, conservatives have taken positions at odds with a strong scientific consensus. Claims that this indicates a broad conservative distrust of science have been countered by assertions that while conservatives might oppose the scientific consensus on climate change or evolution, liberals oppose scientists on some other domains such as vaccines. Evidence for disproportionately liberal bias against science on vaccines has been largely anecdotal, however. Here, we test this proposition of opposite biases using 2014 survey data from Oregon and New Hampshire. Across vaccine as well as climate change questions on each of these two surveys, we find that Democrats are most likely to say they trust scientists for information, and Tea Party supporters are least likely, contradicting the proposition of opposite bias. Moreover, partisan divisions tend to widen with education. Theoretical explanations that have been offered for liberal trust or conservative distrust of science in other specific domains such as climate change or environmental protection fit less well with these results on vaccines. Given the much different content of climate change and vaccine issues, the common political pattern appears more consistent with hypotheses of broader ideological divisions on acceptance of science.

Keywords

climate change, vaccines, trust, scientists, forest management, survey research, partisanship, ideology, liberals, Tea Party, education, interaction

Introduction

In recent years, the science-driven topic of climate change has emerged as one of the most politically divided issues in surveys of U.S. public opinion (Hamilton, 2014). Its correlations with ideology and political party are strong enough to make ideology, party, and climate change opinions look like three equally valid indicators for the same underlying dimension (Kahan, 2015). This has not always been true, of course; a generation ago, ideology and party had much the same meaning as today, while anthropogenic climate change was barely on the public horizon. A countermovement opposing regulations enacted with bipartisan support in the 1970s helped transform environment protection generally, and later climate change in particular, into highly partisan issues (Jacques, Dunlap, & Freeman, 2008; McCright & Dunlap, 2011; McCright, Xiao, & Dunlap, 2014). Scientists whose research detects environmental problems, or anthropogenic climate change, also are seen in an increasingly polarized light.

Across major science topics including not only climate change but also evolution, age of the earth, environmental and health impacts of industrial activities, or biomedical research on stem cells and AIDS, conservative leaders have taken positions at odds with a scientific consensus. Leadership and media personality declarations that evolution and anthropogenic climate change are hoaxes, along with concerted efforts to rewrite high school science textbooks, restrict science at the Environmental Protection Agency (Kollipara, 2014) and National Science Foundation (Mervis, 2014), and defund earth research by the National Aeronautics and Space Administration (Samenow, 2015; Timmer, 2015) provide tangible signs of a partisan "war on science," with support attributed to economic, ideological, religious, and cognitive differences (Mooney, 2005, 2012) or simply to culture (Kahan, 2015). Gauchat (2012) track General Social Survey (GSS) responses to a question on confidence in "the Scientific Community" from 1974 to 2010, finding that "conservatives began the period with the highest trust in science, relative to liberals and moderates, and ended the period with the lowest" (p. 167). He considers historical and political origins for the political divide on science, an area further explored by studies

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including Jacques et al. (2008) and Brulle, Carmichael, and Jenkins (2012).

Claims of a broad conservative distrust of science have been countered by assertions that while conservatives might oppose the scientific consensus on climate change or evolution, liberals oppose scientists on some other core domains, notably vaccines. Opposition to vaccination among the U.S. public has been a potent force with potentially disastrous consequences (Kirkland, 2012; Lillvis, Kirkland, & Frick, 2014; Omer, Salmon, Orenstein, deHart, & Halsey, 2009; Parikh, 2008). A number of commentators have depicted vaccine opposition as primarily a liberal folly, comparable in seriousness and scale to the conservative rejection of climate science (e.g., Berezow, 2014; Hoskinson, 2014; O'Neil, 2014).

In this article, we test the proposition of opposite bias using data from two regional surveys conducted in 2014. Both surveys carried a pair of questions asking respondents whether they trust scientists for information about climate change or vaccines. Our analysis follows the approach taken in research on "the social bases of environmental concern," a substantial literature (since Van Liere & Dunlap, 1980) exploring individual demographic and ideological characteristics as predictors of survey responses on environment-related questions, including trust in environmental scientists (Hamilton & Saito, 2015). Age, gender, education, and political effects have been widely replicated. The social-bases approach adapts well to our goal of comparing people who say they trust scientists on climate change and vaccines. Are these opposite or overlapping groups?

Vaccine Safety Concerns

Vaccine effectiveness and safety have been important topics of medical research. One 1998 paper asserting a connection between vaccinations and pervasive developmental disorders (Wakefield et al., 1998) sparked widespread alarm. Other researchers, however, found no support for this connection, and the Wakefield paper itself was subsequently retracted and debunked as a fraud. Public concern about hypothetical links between vaccination and autism nevertheless remains prominent (Kirkland, 2012). A large-scale review of research on the adverse effects of vaccines, conducted by an Institute of Medicine (IOM, 2012) panel for the National Academy of Sciences, concluded that the weight of evidence clearly favors rejection of the hypothesized relationship between measles-mumps-rubella (MMR) vaccine and autism. Some other hypothesized effects are also rejected, including MMR and type I diabetes, and inactivated influenza vaccine and asthma. But not all adverse effects are discounted. The IOM review concluded that evidence convincingly supports several causal relationships involving the live varicella zoster vaccine, is suggestive though not convincing regarding some other possible connections, and data are too sparse to reach conclusions about still others that

involve rare events. Susceptibility to side effects also may be higher in certain subgroups such as individuals with compromised immune systems. Vaccination preparation and practices have changed in response to research even when findings were not conclusive, as in the precautionary removal of a mercury-based preservative from infant vaccinations by 2001. Vaccine benefits are subject to ongoing research; for example, one recent study identified mechanisms by which measles vaccination prevents other infectious diseases (Mina, Metcalf, de Swart, Osterhaus, & Grenfell, 2015).

Research findings such as the lack of an MMR/autism link leave many vaccine opponents un-persuaded. Surveys and focus groups find parents may distrust government agencies and medical professionals (Raithatha, Holland, Gerrard, & Harvey, 2003), and base their vaccination decisions on personal experience and advice from family members rather than scientific concepts and evidence (Leask, Chapman, Hawe, & Burgess, 2006; Nicholson & Leask, 2012). Brown et al. (2012, p. 1855) study a group of parents doubtful about MMR vaccine and suggest that the shrinking core of parents now rejecting MMR consists mainly of those with "more extreme and complex anti-immunization views." Such views are supported by anti-vaccination websites, where Kata (2012) describes a postmodern perspective that "evidence-based advice from qualified vaccine experts becomes just another opinion among many" (p. 3779). Blume (2006) cautions against seeing resistance to vaccination as a social movement that "shares the radical ideology and disruptive practices commonly associated with other familiar 'movements' (the women's movement, the student movement, the environmental movement)" (p. 630). Instead he argues that this framing diverts attention from a potentially disruptive critique of vaccination practices by parents.

Is this critique disproportionately liberal? Pro- and anti-vaccination arguments can be framed as a clash of ideals between health benefits for the majority of the population, and individual rights and responsibility to decide what is best for one's children. Individual rights or judgment have both liberal and conservative appeal. The idea that chemicals found in vaccines might be dangerous seems resonant with liberal environmental concerns, and distrust of "Big Pharma" pharmaceutical companies fits with some liberal attitudes as well. Doubts about Western medicine more generally are prominent among New Age beliefs (Houtman & Aupers, 2007), which attract more liberals than conservatives (Raschke, 1996). Evidence supporting an alleged liberal bias against vaccination has been largely anecdotal, however, based on arguments from regional stereotypes or celebrity statements (Berezow, 2014; Hoskinson, 2014; O'Neil 2014). Mooney (2012) responds with counter-anecdotes of liberals castigating other liberals for taking an unscientific stance against vaccines. Systematic research finds mixed or no evidence for a widespread liberal bias against vaccines (Kahan, 2014; Lewandowsky, Gignac, & Oberauer, 2013). One 2009 poll found that Democrats were less likely than Republicans

to believe that news media were exaggerating the dangers of swine flu and more likely to say they would get the vaccination themselves (Pew, 2009). Another survey found higher confidence among Democrats that the schedule of vaccines recommended by the Department of Health and Human Services is safe (Berinsky, 2012). In the specific case of the human papillomavirus (HPV) vaccine, conservatives have led strong opposition with the argument that reducing danger from this virus will lead to increased sexual activity by young women (Bernat, Harpin, Eisenberg, Bearinger, & Resnick, 2009; Reitera, McRee, Kadis, & Brewer, 2011).

Our focus in this article is not on vaccine safety, as studied by scientists such as those cited in the IOM (2012) review. Nor do we directly examine anti-vaccination beliefs. Rather, we focus on more general public perceptions of science. Can scientists be trusted for information about vaccines? If not, one presumably harbors doubt about the institutions, individuals, or processes of science itself, and deems other sources more plausible. Then scientific conclusions against adverse effects are not reassuring, and suspicion could generalize to different vaccines and other topics.

Divisions on Science, Climate, and Vaccines

The current wide political divisions across many areas of science seem a stark contrast to reports from post-Sputnik America, where 92% believed that "science is making our lives healthier, easier, and more comfortable" (Withey, 1959, p. 387). Divisions today are especially pronounced regarding anthropogenic climate change, where people who reject its reality also tend not to trust scientists on this topic. Consequently, survey responses on climate beliefs and trust in climate scientists correlate with each other and have similar background predictors. That finding has been subject to differing interpretations, however. Is general distrust in science a causal factor influencing people not to believe that anthropogenic climate change is problematic (Hmielowski, Feldman, Myers, Leiserowitz, & Maibach, 2014)? Alternatively, is climate change rejected for other reasons (Antonio & Brulle, 2011; Campbell & Kay, 2014; McCright & Dunlap, 2010, 2011), and that rejection then spread to climate scientists? One version of this alternative holds that survey responses about climate change and climate scientists behave as indicators for the same thing (Kahan, 2015).

Although Gauchat's (2012) GSS analysis finds liberal/conservative divisions on general confidence in "the scientific community," it remains obvious that not all science is uniformly opposed by conservatives. McCright, Dentzman, Charters, and Dietz (2013) apply Schnaiberg's (1977, 1980) distinction between *impact science*, which could highlight negative externalities from economic activities, and *production science*, which aims to enhance economic production. They find, as expected, that conservatives are more inclined to oppose impact science and favor production science. The impact/production distinction, however, applies less well to other domains such as human evolution that are not economic, but nevertheless marked by strong partisan divisions (Hamilton & Saito, 2015). Seeking a broad measure for trust in science that is not domain-specific, Nadelson et al. (2014) construct a 21-item index which proves to be positively related to liberalism and negatively to religiosity. Kahan (2015), however, shows it is possible to build indexes for *science intelligence* and *climate science intelligence* by choosing a balance of questions alternately biased against liberals or conservatives. A *trust in science* index that is not politically correlated might be assembled with offsetting-bias items, but its interpretation would be difficult compared with individual questions addressing specific, high-salience science domains.

Indirect support for symmetry—conservative rejection of science in some domains balanced by liberal rejection in others—comes from experiments including Kahan (2013), who reports that liberal and conservative opinions about the validity of a three-question cognitive test vary in opposite directions depending on whether subjects are told that people who accept (or in alternate forms, reject) evidence of climate change tend to do better on this test. More directly, Campbell and Kay (2014) describe *solution aversion* in which people doubt the seriousness of a scientifically identified problem because they object to its likely solutions. Climate change provides the archetype for such aversion: Conservative skepticism of consensus statements from climate scientists is reduced when a free-market solution is proposed, while liberal views remain unchanged. Two other experiments (reacting to scientific statements about climate change and the health effects of air pollution) further show solution aversion among conservatives but not among liberals. To find solution aversion among liberals, they run a fourth experiment in which subjects read essays arguing for or against gun control as a solution to home invasions; those who favor gun control are more likely to discount the seriousness of this problem if relaxed gun controls are presented as the solution. Unlike climate change or pollution, however, this gun control manipulation does not reference a broad scientific consensus that exists in real life.

Vaccinations, however, clearly are a domain with strong scientific and medical consensus. Claims of disproportionately liberal bias against vaccinations have been widely repeated, but so far with little empirical support. Kahan (2014) detects no significant political or religious differences in vaccine risk perceptions. Lewandowsky et al. (2013) construct an indicator of attitudes toward vaccination and find that opposition is predicted most strongly by *conspiracist ideation* (tendency to believe in conspiracies), secondarily by a free-market ideology, and most weakly by liberalism. A strong correlation (.85) between their free-market and liberal/conservative dimensions suggests caution, however. Collinearity might complicate interpretation of their opposite-sign partial effects. Other factors such as age, gender,

Table 1. Definitions of Variables, With Weighted Means or Percentages From Surveys in Northeast OR (1,752 Interviews in August to October 2014) and NH (1,061 Interviews in July or October 2014).

Independent variables

Age—Respondent's age in years (18 to 96; OR = 50 years, NH = 48 years).

Gender—Male (0) or female (1; OR = 51%, NH = 51%).

Education—High school or less (–1; OR = 28%, NH = 20%), some college or technical school (0; OR = 32%, NH = 26%), college graduate (1; OR = 26%, NH = 34%), or postgraduate (2; OR = 14%, NH = 20%).

Party—Democrat (–1; OR = 23%, NH = 38%), Independent (0; OR = 16%, NH = 20%), Republican (1; OR = 31%, NH = 23%), or Tea Party supporter (2; OR = 29%, NH = 20%).

Dependent variables

Vaccine—Would you say that you trust (1; OR = 57%, NH = 70%), don't trust (0; OR = 18%, NH = 11%), or are unsure (0; OR = 25%, NH = 20%) about scientists as a source of information about vaccines?

Climate—Would you say that you trust (1; OR = 44%, NH = 63%), don't trust (0; OR = 28%, NH = 14%), or are unsure (0; OR = 27%, NH = 23%) about scientists as a source of information about climate change?

Forest—Oregon only: Would you say that you trust (1; OR = 44%), don't trust (0; OR = 44%), or are unsure (0; OR = 30%) about scientists as a source of information about forest management issues.

Climvax—Coded 1 if respondent does not indicate trust in scientists regarding *either* climate change or vaccines (i.e., *climvax* = 1 if *vaccine* = 0 and *climate* = 0; OR = 33%, NH = 20%).

Note. Codes shown are those used for regressions in Table 2. OR = Oregon; NH = New Hampshire.

and education are not controlled in this analysis nor in several reports that note political differences in response to survey questions about vaccines (Berinsky, 2012; Pew, 2009).

Two Regional Surveys

To test the opposite-bias proposition, we use similarly worded survey questions asking whether people trust scientists for information about climate change or about vaccines. These questions were placed on random-sample surveys conducted in New Hampshire and northeast Oregon in 2014.

Our Oregon survey focused on seven rural counties in the historically resource-dependent northeast corner of the state, whereas the New Hampshire survey was statewide. Both aimed for representative sampling within their respective regions, although New Hampshire encompasses a greater diversity of urban to rural locations and is somewhat closer to representative for the United States as a whole. Previous surveys have found that New Hampshire residents give responses similar to those on national surveys with respect to climate change and some other environmental issues (Hamilton, 2012), whereas northeast Oregon responses tend to be more conservative (Hamilton et al., 2014; Hamilton et al., 2012). The geographic, cultural, and socioeconomic distance between these two regions provides a challenge for replication.

Telephone interviews for both surveys were conducted by trained interviewers at the Survey Center of the University of New Hampshire in summer and fall 2014. The surveys occurred under two different projects:

New Hampshire (Granite State Poll)

This random-sample land line and cell telephone survey of 1,061 New Hampshire residents took place in two stages, in July and October 2014.[1] The Granite State Poll interviews random samples of New Hampshire residents 4 times each year. Along with standard background and political questions, the poll carries questions on climate change and other science-related topics (Hamilton, 2012; Hamilton & Saito, 2015).

Northeast Oregon (Communities and Forests in Oregon [CAFOR])

A random-sample land line and cell telephone survey of 1,752 residents in seven counties (Baker, Crook, Grant, Umatilla, Union, Wallowa, Wheeler) was conducted under the CAFOR project in August through October 2014 (Boag et al., 2015).[2] Earlier, CAFOR research has been described in papers or reports by Hamilton et al. (2012; Hamilton et al., 2014) and Hartter et al. (2014; Hartter et al., 2015).

The Oregon survey, conducted in a rural region where the forest industry and fire risks are salient topics, also asked a third parallel question concerning trust in scientists as a source of information about forest management issues. The wording of these trust questions, along with others used in our analysis, is given in Table 1. Table 1 also lists coding for the logit regression analysis of Table 2.

All analyses in this article use probability weights to make minor adjustments for known sampling bias. Although weighting schemes designed by CAFOR and Granite State Poll researchers differ in their details, they have similar goals. We use each project's original weights here to maintain consistency with other published analyses.

Surveys commonly assess political orientation by asking respondents to self-identify their ideology or political party. Ideological questions might use as many as nine values, from "extremely liberal" to "extremely conservative," or be

Table 2. Odds Ratios From Weighted Logit Regression of Trust in Scientists Regarding Vaccines, Climate Change, or Forest Management, in Northeast OR or NH.

| | Vaccine | | Climate | | Forest | Climvax | |
	OR	NH	OR	NH	OR	OR	NH
Age	0.998	1.001	0.974***	0.981**	0.976***	1.011*	1.007
Gender	1.127	0.735	1.258	0.983	1.066	0.813	1.665*
Education	1.781***	1.441***	1.654***	1.439***	1.800***	0.548***	0.716**
Party	0.786**	0.657***	0.489***	0.521***	0.610***	1.491***	2.014***
Education × Party	0.889	0.855*	0.841*	0.693***	0.863*	1.164*	1.232*
Constant	1.567	2.615	3.798	5.015	3.265	0.234	0.107
Estimation sample	1,552	962	1,552	962	1,552	1,552	962

Note. OR = Oregon; NH = New Hampshire.
*p < .05. **p < .01. ***p < .001.

simplified to just five or three. Similarly, a U.S. political party question might range from "strong Democrat" to "strong Republican," or be simplified to Democrat, Independent, or Republican (in each case, with a residual "other" category that is often too diverse to interpret). Although historical research regarded ideology and party as distinct dimensions, societal trends toward increasing polarization and party sorting (where people choose parties that align with their ideology) have strengthened the correlation between ideological and party measures (Fiorina & Abrams, 2008; Guber, 2012; McCright et al., 2014), so they behave similarly in relation to other survey questions. For example, both ideology and political party questions, in either seven-value or three-value forms, exhibit strong and consistent effects on beliefs about climate change: Liberals or Democrats are much more likely than conservatives or Republicans to agree with the scientific consensus that anthropogenic climate change is real and problematic (e.g., Hamilton, 2011, 2012; McCright & Dunlap, 2011).

Both of our regional surveys asked respondents to self-identify as Democrat, Republican, or Independent. They also separately inquired whether they support, oppose, or are neutral regarding "the political movement known as the Tea Party," which in recent years has become a prominent, strongly conservative force in U.S. politics. Hamilton and Saito (2015) develop these two questions into a four-party classification of Democrats, Independents, Republicans, and Tea Party supporters (whatever their initial party identification).[3] Responses to many science, environmental, or political questions show a strong, ordered gradient from Democrat to Independent to Republican to Tea Party supporter using this scheme. Comparing our two regional surveys, the northeast Oregon sample appears substantially more conservative, consistent with recent voting in that region.[4] We also see that northeast Oregon respondents are several years older than those in New Hampshire and less likely to have college or postgraduate degrees.

Dependent variables for this analysis are three questions about trust in scientists. Does the respondent trust scientists as a source of information about vaccines? About climate change? Or, in northeast Oregon, about forest management issues? Alternatively, do they not trust scientists, or are they unsure? A similar question about trust in scientists for information on environmental issues was asked previously on national, regional, and statewide surveys (Hamilton, 2014; Hamilton et al., 2012; Hamilton & Saito, 2015). Our vaccine version was introduced as an experiment in 2014.

In principle, one might think such questions are ambiguous, because people of any persuasion could believe at least *some* scientists are trustworthy and support their own position. In practice, however, research finds that many responses follow attitudes regarding the domain itself—so much so that perceptions about the risks of climate change and the trustworthiness of climate scientists, for example, arguably behave as if they are indicators for the same thing (Kahan, 2015). Similarly, responses on trusting scientists for information about environmental issues have mostly the same predictors as belief in anthropogenic climate change or support for environmental protection (Hamilton & Saito, 2015).

Who Trusts Scientists?

Figure 1 graphs response to our climate, vaccines, and forestry trust questions. On both surveys, a majority say they trust scientists about vaccines, although this majority is larger in New Hampshire (70% vs. 57%). Climate change, often a polarizing topic, evinces less trust on both surveys (63% vs. 44%). In northeast Oregon where the forest management question was asked, it brought responses similar to climate change (44% trust scientists). Forest management and science in this region are probably associated in many people's minds with environmental protection or the U.S. Forest Service. Both our 2011 and 2014 northeast Oregon surveys found widespread doubts about local impacts from environmental rules. They also found concerns that the Forest Service is not doing enough, or not doing the right
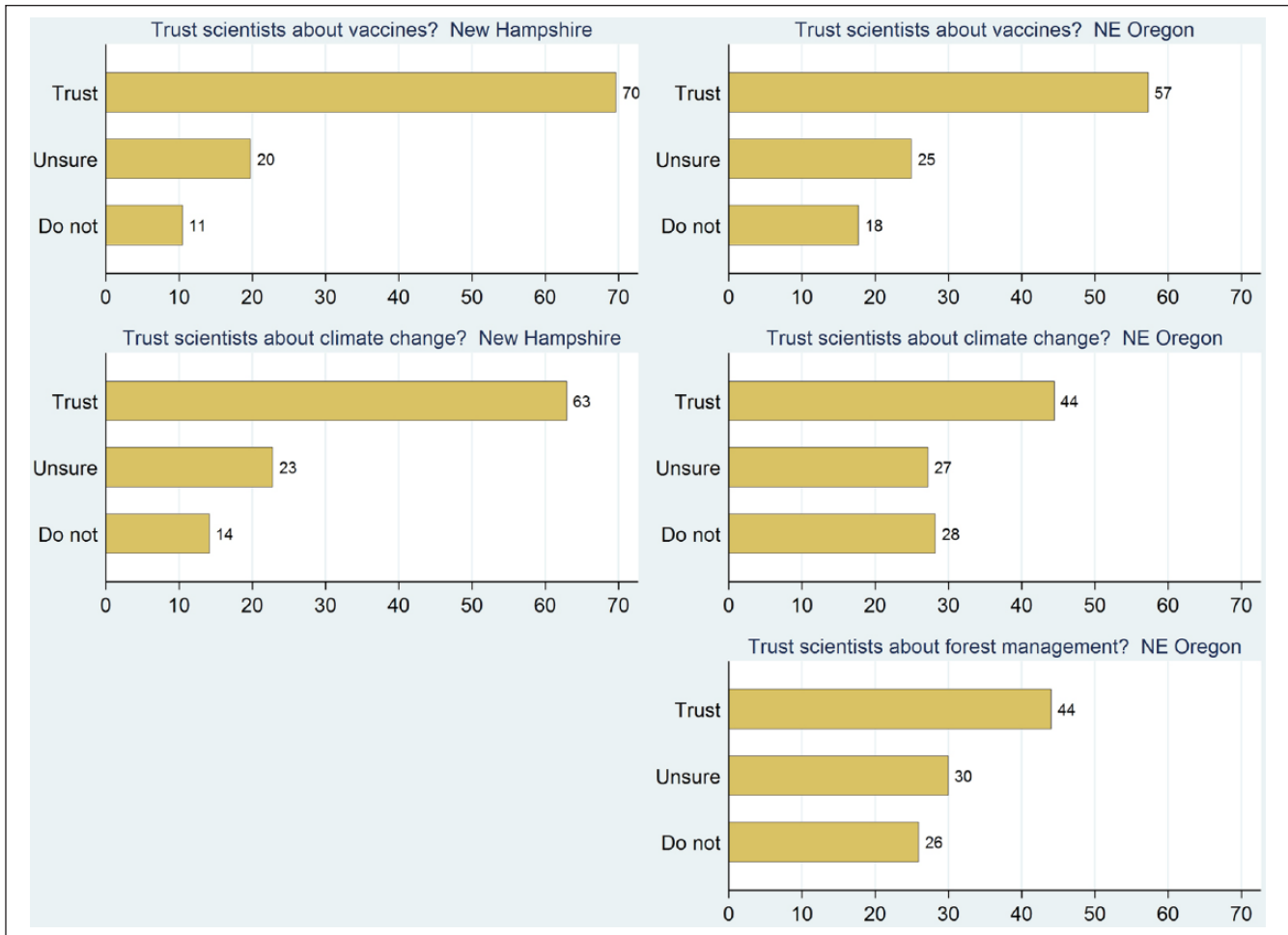
Figure 1. Weighted percentages for three "trust scientists" questions on New Hampshire and NE Oregon surveys.
Note. NE = Northeast.

things, to manage forests that have great importance for local landscapes and livelihoods.

Education and political orientation, two individual characteristics that often predict views on science, do so consistently in our data as well. Figure 2 graphs the percentage of "trust-scientists" responses by education, across two surveys and three questions. In all five charts, trust is highest among those with postgraduate education and lowest among respondents with high school or less. Overall levels of trust tend to be lower in northeast Oregon, but education gradients there are steeper. Among Oregon respondents with high school or less education, fewer than half (34%-41%) trust scientists on vaccines, climate change, or forest management. Among New Hampshire residents with high school or less, more than half (53%-58%) trust scientists on vaccines or climate.

Political orientation has been shown to be a consistent predictor for indicators of trust in scientists generally (McCright et al., 2013) or more specifically regarding environmental issues (Hamilton & Saito, 2015). It proves similarly consistent as a predictor of the three domain-specific

trust questions here. Figure 3 breaks down trust-scientist responses by political party. For both surveys and all three questions, trust is highest among Democrats and lowest among Tea Party supporters.[5] Regarding climate change, that pattern agrees with all previous research. The northeast Oregon forest management result is unsurprising as well. Science on forest management in that region has often been associated not only with government but also with environmental or endangered-species protection—examples of *impact science* (McCright et al., 2013; Schnaiberg, 1977, 1980) and grounds for conservative *solution aversion* (Campbell & Kay, 2014). However, neither impact science nor solution aversion theories predict that trust regarding vaccines would be greater among Democrats (75% or 82%) compared with Tea Party supporters (51% or 52%). This result contradicts claims of a liberal anti-science bias on vaccines.

The bivariate trust/party relationships in Figure 3, like the trust/education relationships in Figure 2, all are statistically significant ($p < .05$, from design-based F tests). Other background
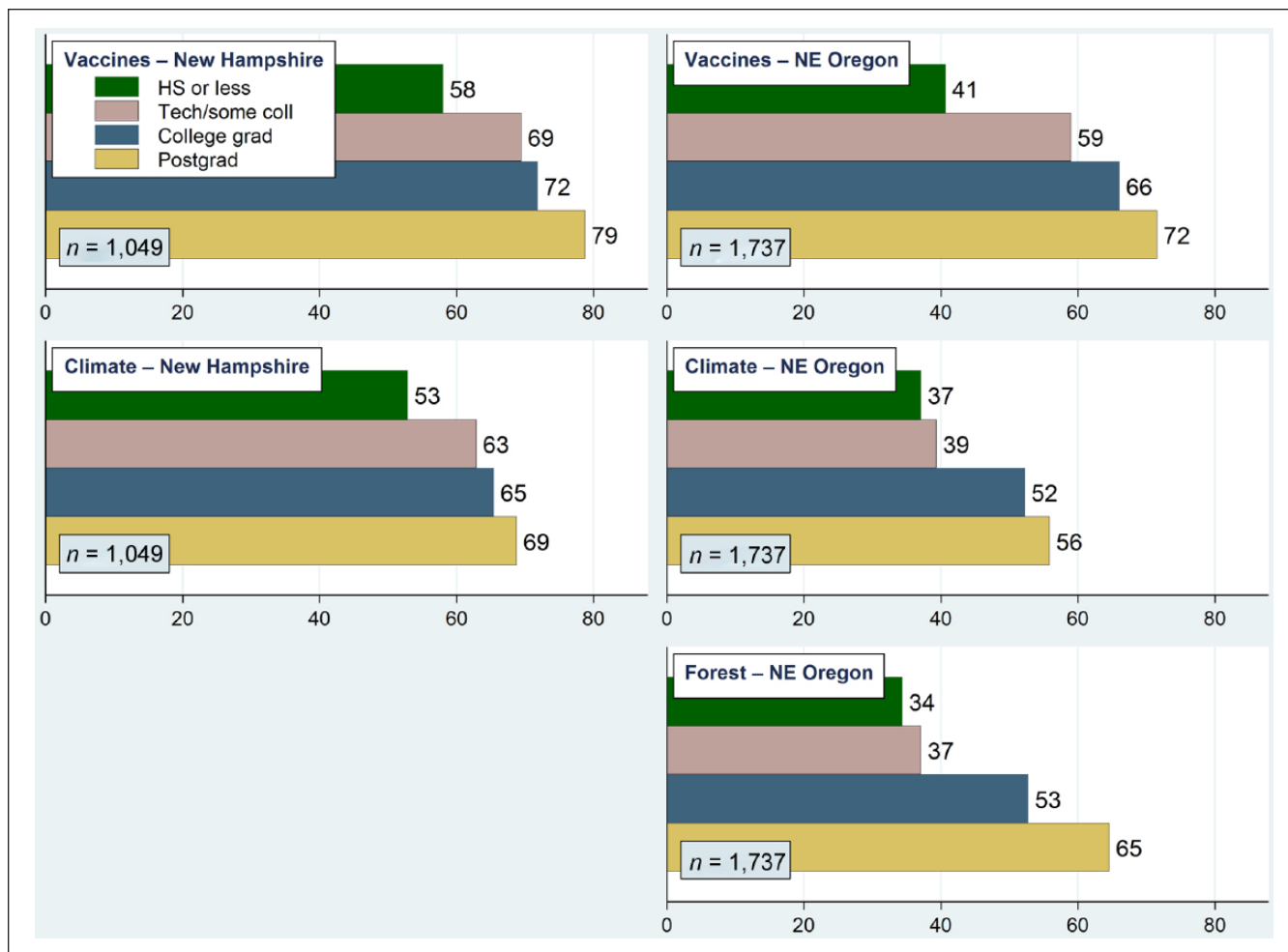
Figure 2. Weighted percentage who trust scientists, by education.
Note. HS = high school; NE = Northeast.

characteristics such as age and gender often correlate with education or party, however, raising the question of whether relationships in these charts might partly be spurious. Moreover, education and political party often exhibit interaction effects that make additive models misleading. The next section tests these ideas.

Interaction Effects

Survey research on climate change perceptions often detects interaction effects involving education and politics, the two key variables noted above. Education exhibits positive effects on perceptions about the reality or risk of anthropogenic climate change among liberals and moderates (or Democrats and Independents) but a weak or even negative effect among conservatives (or Republicans). First observed in GSS data by Hamilton (2008), *education × politics* interactions were subsequently confirmed using other climate questions and surveys (Hamilton, 2011, 2012; Hamilton & Keim, 2009; McCright, 2011; McCright &

Dunlap, 2011; Shao, Keim, Garland, & Hamilton, 2014). Variations with a similar flavor include objectively tested *science literacy × politics* (Hamilton et al., 2012), *numerical literacy × worldview* (Kahan et al., 2012), and self-assessed *understanding × politics* (Hamilton, 2011; McCright & Dunlap, 2011).

Studies have also found similar interactions regarding a number of non-climate environmental questions (Hamilton, Colocousis, & Duncan, 2010; Hamilton et al., 2014; Hamilton & Safford, 2015). For example, Hamilton and Saito (2015) report *education × party* interactions affecting not only climate measures but also belief in human evolution and whether people say they trust scientists for information about environmental issues. We expected to see such interactions regarding trust in scientists on climate change. Theory does not predict, and previous studies have not tested, whether similar interactions might occur regarding trust in scientists on vaccines.

The general pattern of the *education × politics* (and similar) interactions fits with several overlapping theoretical
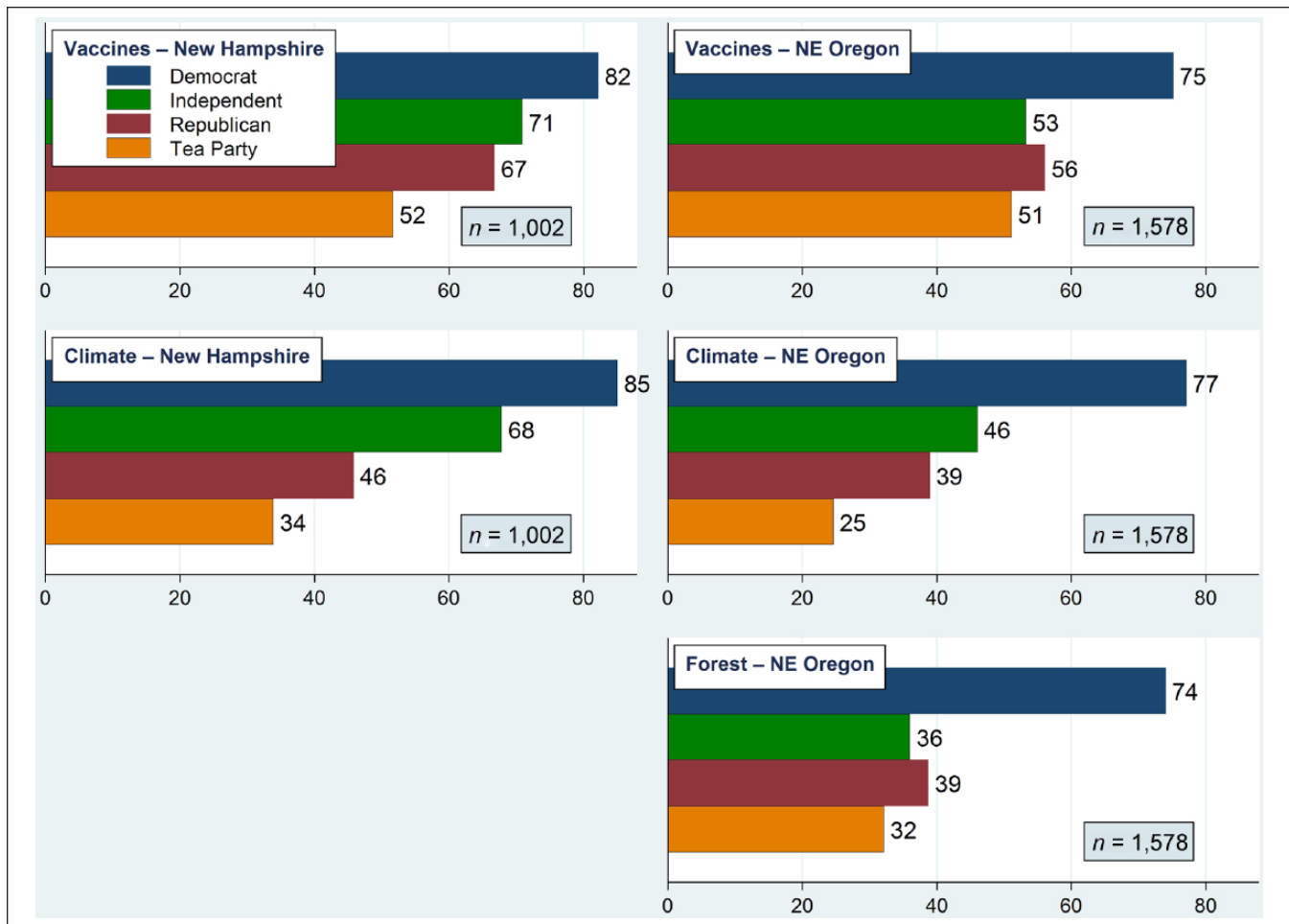
Figure 3. Weighted percentage who trust scientists, by political party.
Note. NE = Northeast.

frameworks, notably *biased assimilation* (Corner, Whitmarsh, & Xenias, 2011; Munro & Ditto, 1997) and *elite cues* (Brulle et al., 2012; McCright et al., 2014). A common theme in these frameworks is selective acquisition of information that supports existing prejudices, whether from peer groups, political leaders, news media, or other sources. General news media often provide "balanced" coverage from which ideologically agreeable information can be filtered (Boykoff, 2013). Alternatively, information can be pre-filtered by choosing biased web or media sources. To account for the Education × Politics interaction effects, a common inference has been that information elites can be more efficacious in biased assimilation or perceiving elite cues. That is, they more actively acquire information to reinforce their ideological beliefs.

Table 2 shows results from seven models including *education × party* interaction effects on trust in scientists about vaccines, climate change, or forest management, separately for the Oregon and New Hampshire surveys. The last two columns depict the composite dependent variable *climvax*, denoting individuals who do not say they trust scientists on

either climate change or vaccines. All models also include respondent age and gender as control variables.[6] The coefficients shown are odds ratios from weighted logit regressions. They represent the multiplicative effects of a one-unit increase in each independent variable on the odds favoring a "trust-scientists" response (or for the last two columns, the lack of trust in scientists).[7] Thus, for the northeast Oregon survey, each 1-year increase in respondent age multiplies the odds of trusting scientists for information about vaccines by 0.998 (a 0.2% change), which is trivial and not significant. *Age* does have significant effects on trust regarding climate change or forest management. In each case, older respondents are less inclined to trust scientists. Gender shows a significant effect only on *climvax*, in New Hampshire.

The main effects of *education* describe the effects of *education* when *party* = 0, that is among political Independents. These *education* main effects are statistically significant across all seven models, indicating that among Independents, the odds of trusting scientists about vaccines, climate, or forest management increase (multiplied by 1.439 to 1.800, that is, rise by about 44% to 80%) with each level of education.
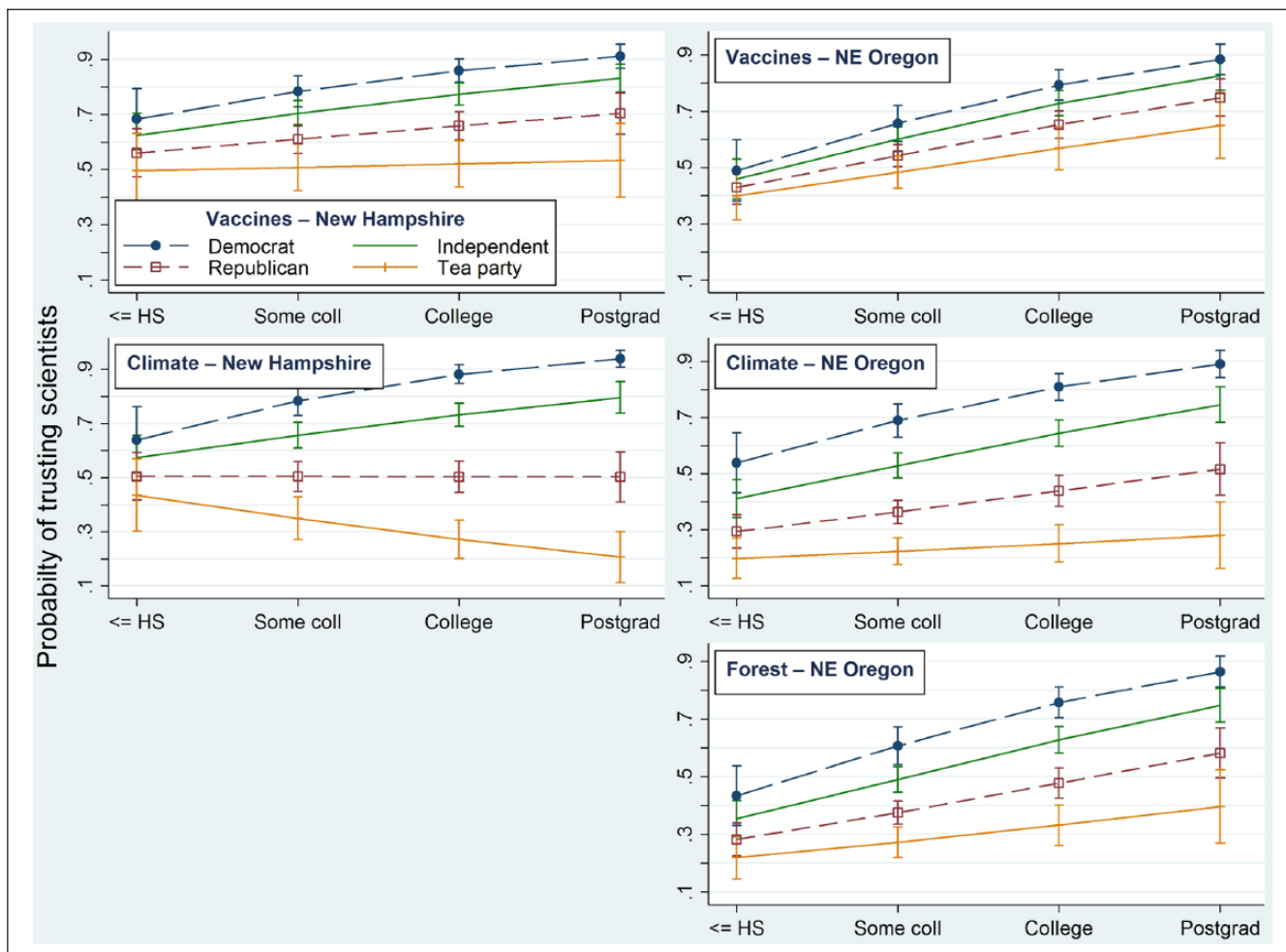
Figure 4. Interaction effects: Predicted probability of trust in scientists as a function of education and political party, controlling for age and gender.

Note. HS = high school; NE = Northeast.

The odds of *not* trusting scientists on either vaccines or climate decline with education.

Political *party* main effects likewise are significant across all trust questions and both surveys. For the positively coded questions in columns 1 to 5 (Table 2), these odds ratios are all below 1.0, meaning the odds of a "trust scientist for information" response declines moving from Democrat to Independent, Republican, and Tea Party supporter. In the Oregon survey, for example, odds of trusting scientists about vaccines decline by an average of 21% (are multiplied by 0.786) with each level of *party*. In the New Hampshire survey, odds of trusting scientists about vaccines decline by 34% (multiplied by 0.657) with each level of *party*. Both results contradict assertions that liberals are more likely to reject science regarding vaccines; instead, the opposite is true. *Party* effects are even stronger regarding climate change, where each level reduces the odds of trusting scientists for information by an average of 51% (northeast Oregon) or 48% (New Hampshire).[8]

The *education × party* interaction terms are statistically significant across six of our seven models and take the same direction in all. Education exerts the strongest positive effect on trust among Democrats and a somewhat weaker but still positive effect among Independents. Among Republicans and Tea Party supporters, education effects are closer to zero. Figure 4 visualizes these relationships with adjusted marginal plots calculated from the first five logit models of Table 2. Among Tea Party supporters, trust in scientists regarding climate change actually declines with education, consistent with results in Hamilton and Saito (2015) that used a different climate question and a categorical rather than ordinal party indicator.

The other interactions in Figure 4 are weaker but have the same direction. Trust in scientists on each topic rises steeply with education among Democrats and Independents, and rises less steeply or not at all with education among Tea Party supporters. The replications in Figure 4 extend the domains over which we have seen political divisions widening with

education, to now include trust in scientists about forest management and vaccines. Biased assimilation, elite cues, and similar theories account for such patterns (regarding climate change, for example) in terms of more effective and motivated acquisition of information. With respect to vaccines, this might, depending on one's prejudices, go in one direction toward greater awareness of medical studies and advice or in the opposite direction toward anti-vaccination sources such as the websites described by Brown et al. (2012) or Kata (2012). In both directions, such motivated information-seeking has analogues on the topic of climate change.

What is the demographic profile of those who do *not* trust scientists on either of our two main questions? We explored this in Table 2 by defining a new variable, *climvax*, denoting those respondents who do not trust scientists on climate change and do not trust them on vaccines. This untrustful group comprises one third of our Oregon sample and one fifth of those from New Hampshire. The last two columns in Table 2 show that this composite indicator for lack of trust has dominant political effects that mirror those for the vaccine, climate, and forest indicators individually. Democrats are least likely and Tea Party supporters most likely not to trust scientists on either vaccines or climate change. We also see significant *education × party* interaction effects on *climvax* that mirror those for the individual indicators: The odds of trusting scientists on neither vaccines nor climate change decline most steeply with education among Democrats and decline less steeply (northeast Oregon) or actually increase (New Hampshire) with education among Tea Party supporters.

Discussion

New Hampshire and northeast Oregon differ in many ways, so finding common patterns across both surveys suggests the conclusions are robust. The common patterns involve higher liberal and lower conservative trust in scientists, something already well documented regarding climate change (e.g., Campbell & Kay, 2014; McCright & Dunlap, 2011) and environmental issues (Hamilton, 2014; Hamilton & Saito, 2015; McCright et al., 2013). Unexpectedly, we find that this occurs also with vaccines, a topic where stereotypically liberal arguments exist (e.g., concern about chemicals and big corporations), and some observers have claimed to see the liberal counterpart to conservative rejection of climate science. Our contrary finding brings up a question raised by others: Are conservatives generally less inclined to trust scientists? Mooney (2005, 2012), drawing on ideological, economic, psychological, and even physiological studies, has argued in the affirmative. Other studies reporting higher liberal or lower conservative support for science include Gauchat's (2012) analysis of a general GSS question and work by Nadelson et al. (2014) on a multi-item scale.

Narrowing their focus to bias regarding specific science domains, McCright et al. (2013) find patterns consistent with theoretical predictions involving impact science versus production science; Campbell and Kay (2014) propose a somewhat overlapping theory of solution aversion. Both theories fit our climate change and forest management results, but neither fits our finding on vaccines. The impact versus production theory predicts that conservatives should favor science that serves economic needs, which vaccine research does both for pharmaceutical companies and public health.

Solution aversion suggests that skepticism toward science is motivated by aversion to ideologically objectionable solutions such as pollution control, but that does not match the vaccination case either. Adverse reactions to vaccines are objectionable to everyone regardless of ideology and, certainly, to physicians and medical scientists; they are the focus of studies and conclusions in the IOM (2012) report, for example. A more ideological conservative objection could be that vaccinations often involve government (Salmon et al., 2005), although anti-vaccination rhetoric has mainly emphasized child safety (Brayden & Wall, 2008; Kirkland, 2012). There might also be connections through Lewandowsky et al.'s (2013) idea of conspiracist ideation, not testable with our data but needing further research in this framework.

Our surveys do not ask whether people think that vaccines are safe. With regard to specific vaccines, that is a topic of past and continuing research. The surveys ask whether people think that scientists can be trusted for information on this topic. Democrats are most likely, and Tea Party supporters least likely, to say yes. This political pattern in vaccine and climate change responses, despite the much different content and concerns in those domains, appears consistent with hypotheses of broader ideological divisions on acceptance of science. Behavior of our combined indicator for who does not trust scientists on *either* domain points in this direction as well.

The pattern of liberal trust and conservative distrust of science appears broad in that it extends across many domains, to which we now add vaccines. Further domains need testing in future research, but even if those follow the same pattern, it would not necessarily imply divergent attitudes toward "science" as a general abstraction. More concretely, the observed patterns show divergent views regarding scientific evidence in areas that have a strong consensus among scientists, but where public divisions exist and ideology may supply different answers.

Authors' Note

Declaration of Conflicting Interests

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Notes

1. Response rates of 24% and 22%, by the American Association for Public Opinion Research (AAPOR; 2006) definition 4.
2. Response rate 33%, by the AAPOR (2006) definition 4.
3. People who declined to answer either political question are set aside for these analyses.
4. For example, in 2012, President Obama received from 22.1% to 34.5% of the votes cast in these northeast Oregon (OR) counties, compared with 52.2% in the state of New Hampshire (NH) and 51.1% nationwide.
5. Separating out Tea Party supporters builds a fourth political group consisting of 2% (OR) or 9% (NH) of those who originally self-identified as Democrats; 7% (OR) or 17% (NH) of Independents; 38% (OR) or 40% (NH) of Republicans; and 30% (OR) or 19% (NH) of those who originally self-identified as "other" or gave no affiliation. Using just Democrat/Independent/Republican instead of our four-party scheme consequently would have little impact (two points or less) on any of the Democrat percentages in Figure 3. With either coding, Democrats are most likely to trust scientists on all measures in both surveys. Three-party coding also would have little impact on the Independent percentages of Figure 3: two points or less regarding vaccines or climate and four points regarding forest management. Under a three-party coding, the Republican percentages become intermediate between Republican and Tea Party percentages shown in Figure 3. However, combining this heterogeneous group overlooks what are often wide and politically consequential differences between Tea Party and non-Tea Party Republicans (Hamilton, 2014; Hamilton & Saito, 2015).
6. McCright et al. (2013) report that religious identification also affects trust in science. We looked for a similar pattern in our New Hampshire data using a standard question about frequency of religious service attendance but that proved to have no effect on climate or vaccine responses. A religion question was not asked on our Oregon survey.
7. The first five models in Table 2 use dichotomous dependent variables, coded 1 if the respondent says they trust scientists and 0 otherwise. Alternatively, these survey questions can be coded as ordinal (distrust/unsure/trust) and analyzed by ordered logit regression. Ordered-logit versions yield basically the same conclusions as the binomial models in Table 2, however. For parsimony, we prefer the dichotomous versions in Table 2.
8. Our four-value political party indicator is treated as ordinal in these models, but we also tested versions with party treated categorically as a set of dummy variables (see Hamilton & Saito, 2015, for examples using the latter approach). Both versions yield similar conclusions. Because our substantive focus

in this article is on the liberal-to-conservative gradient rather than contrasts between individual party pairs, we prefer the simpler ordinal approach here.

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