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Renewable energy policy design and framing influence public support in the United States

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The United States has often led the world in supporting renewable energy technologies at both the state and federal level. However, since 2011 several states have weakened their renewable energy policies. Public opinion will likely be crucial for determining whether states expand or contract their renewable energy policies in the future. Here we show that a majority of the public in most states supports renewable portfolio standards, which require a portion of the electricity mix to come from renewables. However, policy design and framing can strongly influence public support. Using a survey experiment, we show that effects of renewable portfolio standards bills on residential electricity costs, jobs and pollution, as well as bipartisan elite support, are all important drivers of public support. In many states, these bills' design and framing can push public opinion above or below majority support.

The United States has one of the highest per capita carbon emissions in the world.[1, 2, 3] Despite global progress, political barriers still hamper attempts to transition the electricity system away from fossil fuels towards renewable energy technologies in the US and globally.[4, 5] In most public opinion polls in the US, public support for climate policy is lower than for renewable energy policies, although these differences vary over time.[6, 7] For this reason, renewable energy policies may be one way to secure climate benefits while maintaining public support for action.

In line with this broad public support, states have taken a leadership role in supporting renewable energy since the 1980s [8, 9], with 37 states enacting binding or voluntary renewable portfolio standard (RPS) policies. These laws require a portion of the electricity mix to come from renewable sources by a given date. However, since 2011, new RPS policy adoption in the states where they do not exist, and expansion of existing policies whose goals have already been met, has slowed. Instead, the past several years have seen numerous attempts to weaken, freeze or repeal renewable energy laws, with some efforts proving successful.[10, 11]

Given the 2016 presidential election's outcome, increased federal investment in renewable energy is unlikely over the next few years.[12] Instead, we can expect state-level renewable energy policies to be central to driving new deployment. While many factors influence

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renewable energy policy adoption, including environmental problems like air pollution, partisanship, and interest group advocacy and opposition, past research has shown that public opinion can play a crucial role in facilitating a political consensus around new policies in US states, including renewable energy and climate policies.[13, 14, 15] Advocates and opponents use public opinion to communicate with politicians, arguing that policies should be expanded or retrenched.

In this paper, our first aim is to understand whether there is policy congruence: are states with majority public opinion support for RPS policies more likely to have these policies? To answer this question, we look at existing public opinion data, comparing it across states with and without RPS policies. Next, we examine whether the design and framing of RPS policies affects public opinion. Could RPS policies' design and framing increase public support, helping to drive adoption in places where binding policies do not exist, and increasing the targets in places where they do? We examined this question using a survey experiment administered to a large national sample of the US population.

Public support may influence RPS policy adoption, but, at the same time, the design and framing of a bill could affect public support for RPS policies. For instance, earlier research has shown that economic conditions influence support for energy policies and technologies [16, 17, 18], and that Americans prioritize cheap energy.[7, 17] Since energy is often seen as a commodity, citizens would rather pay less for the good. For this reason, highlighting costs could decrease support for RPS policies. Other economic impacts, most notably employment effects, may also be a key factor underlying support for energy policy. For many states, anticipated job creation was a key factor in initial support for RPS policies.[10, 19]. Citizens may be concerned that moving away from fossil fuels may cause job losses, and may therefore support alternatives to a greater extent if they believe they will create jobs. For this reason, public support for new energy technologies may be contingent on their employment effects, with greater support when jobs are emphasized, and lower support when it is suggested that renewables will not create new jobs.

Clean air is another proposed reason why people support renewable energy policy.[7] Specifically, local air quality benefits from reducing fossil fuel combustion in a state's electricity sector are likely to be salient for public support. Consequently, information on likely air pollution benefits from the bill may increase support for an RPS policy.

By contrast, framing these policies around climate change may mean that citizens see RPS policies' benefits as more global than local, since citizens see climate change as a global problem.[7] Thus, global benefits are not likely to increase support for renewable energy. In addition, there is strong partisan polarization on climate change.[20, 21] Theoretically, then, we might expect to see differential effects across partisans if climate change is primed.

Finally, in other policy domains, partisan cues are found to be important to explaining patterns of support.[22, 23] It is therefore reasonable to expect that partisans should respond to partisan primes (like elite support) on energy policy as they would for other domains, moving towards their copartisans. However, some research suggests that partisanship is not important for energy policy.[7]

In this paper, our first aim is to understand whether there is policy congruence: are states with majority public opinion support for RPS policies more likely to have these policies? Comparing public opinion data across states with and without RPS policies reveals broad congruence. Next, we examine whether the design and framing of RPS policies affects public

opinion. Could RPS policies' design and framing increase public support, helping to drive adoption in places where binding policies do not exist, and increasing the targets in places where they do? We examined this question using a survey experiment administered to a large national sample of the US population. The results suggest that public support could be even higher if policies are framed and designed with air quality benefits and job creation in mind. Republicans, who have lower overall support for these policies, increase their support if Republican politicians take leadership roles in supporting proposed bills, and if air quality benefits are emphasized. However, public opinion is sensitive to cost increases as low as $2 a month. For this reason, imposing costs through residential rate increases may lead to a popular backlash against renewable energy policies. Thus, paying for renewable energy policies using alternative revenue sources, such as carbon tax revenues, may be important to sustaining public support over the long term.

Baseline Public Support for Renewable Energy

Figure 1 shows current public support for an RPS policy in each state that "requires the use of a minimum amount of renewable fuels (wind, solar, and hydroelectric) in the generation of electricity even if electricity prices increase a little" based on a very large survey of over 56,000 Americans.[24] Overall, a majority of the public supports renewable energy requirements in the vast majority of states. The strongest support for RPS policies is in northeastern states and states with high wind energy potential (e.g., New Mexico, Iowa, and Kansas). The weakest support is in southern states, where RPS policies largely do not exist, and in the mountain states. Overall, the proportion supporting RPS policies in this survey is in line with findings from a number of other surveys examining the same issue, with slightly different question wordings (Supplementary Note 1 and Table 1).[25]

Despite this strong majority support across the country and across most states, not every state has acted, and some states are considering weakening or repealing these policies. Figure 1's right axis categorizes the current RPS policy target in each state. There is a strong correlation between public support for renewable energy policies and each state's current policy. Overall, 38 states (including the District of Columbia) have RPS policies that are congruent with the views of a majority of their citizens, while 13 do not. All thirteen states where more than 60% of the public supports an RPS have a binding RPS policy, with varying levels of ambitiousness. As public support drops close to, or below, 50% states are much less likely to have a binding RPS. Of course, the correlation between public opinion and policy outcomes could be influenced by policy feedback, wherein the policies themselves change public opinion. It could also be influenced by interest groups, partisanship, and other factors. Overall, however, these findings suggest that state legislators are broadly responsive to public opinion on this issue. If public support for renewable energy policies increased, we could expect to see more renewable energy laws.

Effect of Policy Design and Framing on Public Support

Next, we examined how the design and framing of RPS policies' affects public support for these policies using a survey experiment administered to a large national sample of 2,500

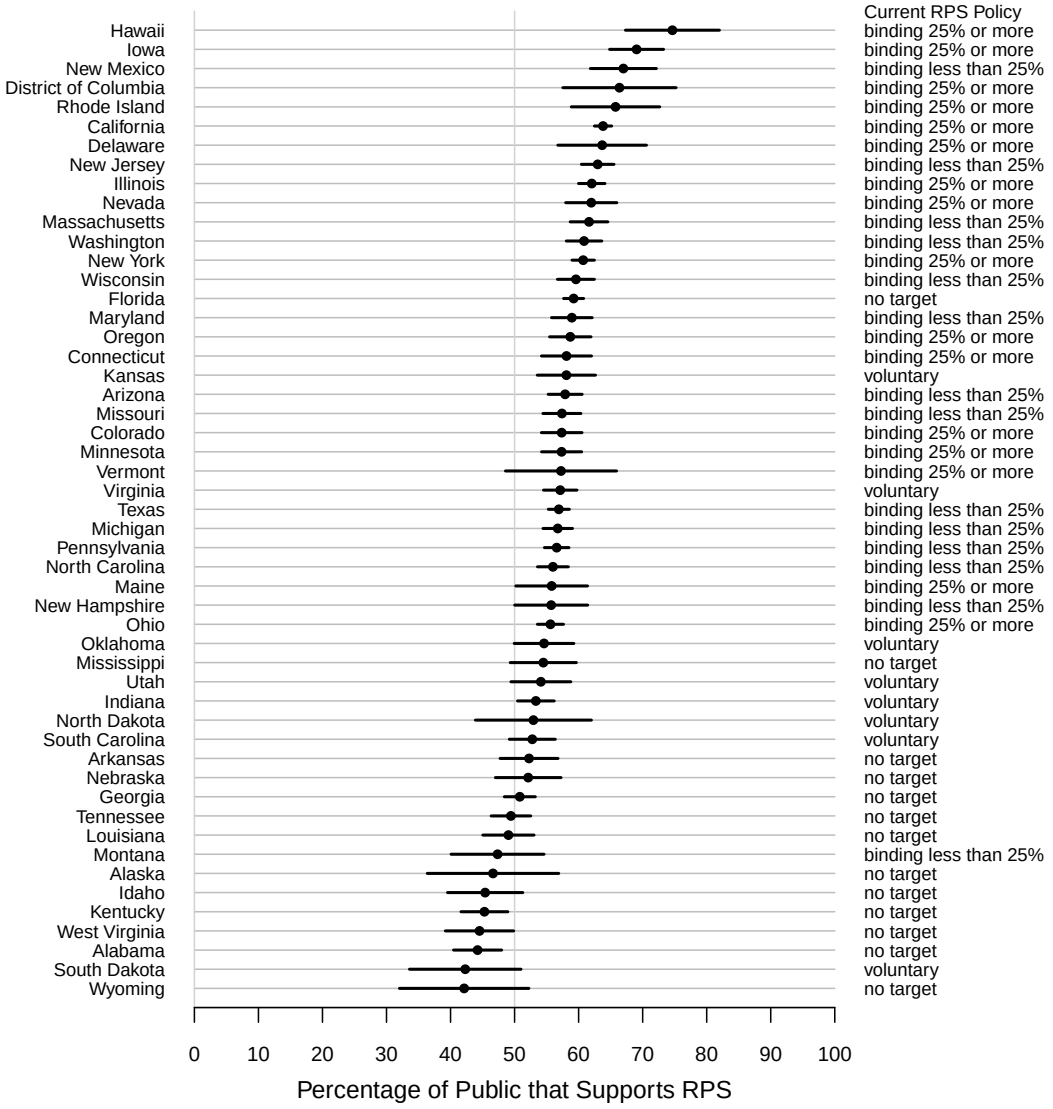

Figure 1: Support for Renewable Energy Portfolio policies in each state. The right axis indicates the current policy in each state. Data is from the 2014 Cooperative Congressional Election Study,[24] which surveyed over 56,000 people across the country. Error bars show 95% confidence intervals.

respondents. We showed respondents information about a hypothetical renewable energy bill. We then presented them with a variety of randomized pieces of information about the bill, including its potential cost, effect on jobs, air quality and climate impacts, as well as a partisan prime (See Methods section for details).[23] Overall, our approach is similar to a conjoint-based experimental design, albeit without requiring respondents to choose among alternatives.[26] The fully randomized design enables us to estimate the causal effects of

multiple treatment components and assess several hypotheses simultaneously. After receiving randomized information about the bill, respondents were given a 4-point scale to gauge their support for the bill, from strongly support to strongly oppose. To estimate the average treatment effect for each variation in the bill's design or political support, we ran an ordinary least squares (OLS) regression that included all of the treatments.

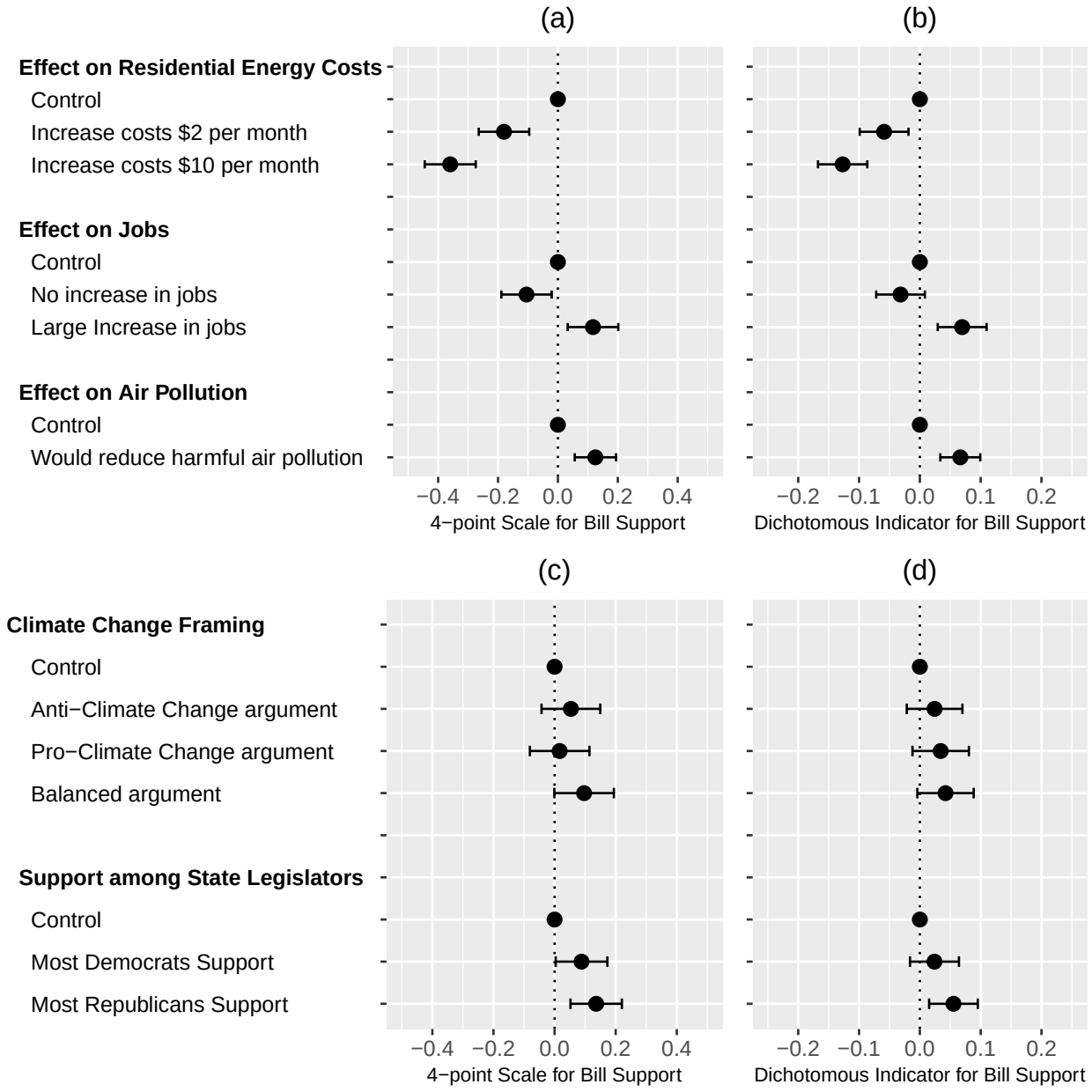

Figure 2: The effects of each treatment on respondents' support for a renewable portfolio standard in the respondent's state. Effects of policy design on a) a 4-point scale and b) dichotomous scale. Effects of framing on c) a 4-pont scale, and d) a dichotomous scale. All results are plotted relative to the control group for each treatment. Error bars show 95% confidence intervals.

The main results from the survey experiment are shown in Figure 2. We find that a modest $2 per month increase in utility bills decreases respondents' support for an RPS by about 0.18 on a four point scale (Figure 2a) and shifts 6% of respondents from supporting the bill to opposing it (Figure 2b). A larger, $10 increase in residential utility bills decreases support by 0.36 (Figure 2a) , shifting 13% of respondents from support to opposition (Figure 2b). In order to aid in the substantive interpretation of these results, we extrapolate from our survey experiment findings to the resulting public opinion in each state. We assume constant effects across states. We attempted to validate this assumption by analyzing the results for each of the four major US regions and found they are largely similar (Supplementary Table 2). Assuming a constant treatment effect across states in response to the $10 cost prime, this change in support levels could cause 33 states to flip from a majority support for an RPS to a majority in opposition. Such a large change in residential electricity costs would not happen immediately from new RPS policies—it would take many years.[27] Still, this finding suggests that citizens are very sensitive to cost frames, and it is in line with findings from other public opinion poll questions that emphasize costs.[25] Asking citizens, through residential rate increases, to bear the costs of transitioning the electricity system may lead to a backlash as these costs add up over the longer term. For this reason, paying for the policies using alternative revenue sources, such as carbon tax revenues, may be important to sustaining public support.

Next, we examined how variation in job creation could affect public support for an RPS. We found that public support would drop significantly (0.1 on 4-point scale (Figure 2a), 3.2% on dichotomous scale (Figure 2b)) if an RPS did not create any jobs. Assuming constant treatment effects across states, this could cause five states to flip from a majority supporting an RPS to a majority in opposition to an RPS. In contrast, support for an RPS would increase substantially if it led to a large increase in jobs (0.12 on 4-point scale, 7% on dichotomous scale). Similarly, if citizens understood an RPS bill would reduce harmful air pollution such as mercury, it would increase public support by the same amount (0.13 on 4-point scale, 6.7% on dichotomous scale). Emphasizing either job creation or air quality benefits could cause eight of the ten states where a majority opposes RPS bills, and where RPS policies largely do not exist, to flip to a majority in support, if treatment effects are constant across states.

We also examined several aspects of how bills are framed and messaged. First, we examined the impact of emphasizing the link between renewables and climate change. All three climate change messages returned null effects (Figures 2c and 2d). Framing the bill as contributing to a climate solution, framing climate change as unimportant, or providing both views simultaneously all appear not to shift support. This may suggest that messaging on climate change when promoting renewables is largely ineffective. It could also suggest that many people already associate renewables with climate change, and thus, our experiment did little to change people's views.

Finally, the last set of treatments examined how different configurations of elite support for the RPS bill affect public opinion. Previous work has shown elite opinion and partisan cues can have a strong influence on public opinion.[22, 23] Similarly, our results indicate that elite support for an RPS bill can significantly influence public support. Compared to a control group, where respondents were given no information about elite positions, informing respondents that a majority of Democratic state legislators supported the bill led public support for an RPS bill to increase by 0.09 on a 4-point scale (Figure 2c). In addition,

informing respondents that a majority of Republican state legislators for the bill led public support to increase by 0.14 on a 4-point scale (Figure 2c), shifting 5.5% of respondents from opposing the bill to supporting it (Figure 2d). This would cause seven of the ten states without majority support to flip into majority support for RPS policies, if these treatment effects are constant across the states.

Partisan Differences in Framing Effects

We might also expect the effect of partisan cues to vary based on the respondent's partisan affiliation. Indeed, Figure 3c shows that if Democratic state legislators support the bill, Democratic respondents are more likely to support it. Likewise, Figure 3d shows that if the bill is supported by Republican state legislators, Republican respondents are much more likely to support it. Importantly, if the other party sponsors the bill, this does not seem to drive down support among opposite-party voters. For instance, support by Democratic state legislators does not decrease support among Republican voters.

We also found that Republicans are more likely to increase their support for the bill if air pollution benefits are highlighted (Figure 3b). The results suggest that in order to increase support among Republicans, who have lower average support for renewable energy policy overall [24], Republican state-level champions and a focus on air pollution, are critical. Notably, there is no evidence of substantial heterogeneity across parties for any of the other treatments, such as the costs or job creation (Figures 3a and 3b).

Conclusion

Action on climate change remains critical. In the United States, we can expect states to be the main actors on renewable energy policy in the coming years. Overall, we find that a majority of the public across every state supports renewable energy policies if public health benefits and job creation are emphasized. Republican leadership is also essential, particularly in Republican-dominated state legislatures. If, however, costs are imposed on residential ratepayers through rapid bill increases tied to renewable energy policies, this will very likely undermine support. In fact, emphasizing cost increases of $10 a month would likely decrease public support more than emphasizing air quality, job creation or partisan primes would increase it. It is important to note that such a large monthly increase is very unlikely in the short term.[27] Still, if RPS policies are accurately or inaccurately blamed for rising utility bills, this will undermine public support.

Given that there are many states where a majority support RPS policies, yet no policies exist, coordinated efforts from advocacy groups may be necessary to raise public opinion's salience or raise it above a two-thirds supermajority. Some states where these policies do not exist have highly carbon-dependent economies, including in West Virginia where an RPS was repealed, and in South Dakota and Wyoming. These states may be particularly resistant to transitioning away from fossil fuels. Although in this paper we have examined public opinion, future research could also build on studies that examine behavior, such as willingness to pay for renewable energy, or how local wind and solar deployment affect political behavior.[28, 29] As politicians and advocates attempt to advance new renewable energy laws in the states, our results suggest careful consideration should be given to their framing and implementation.

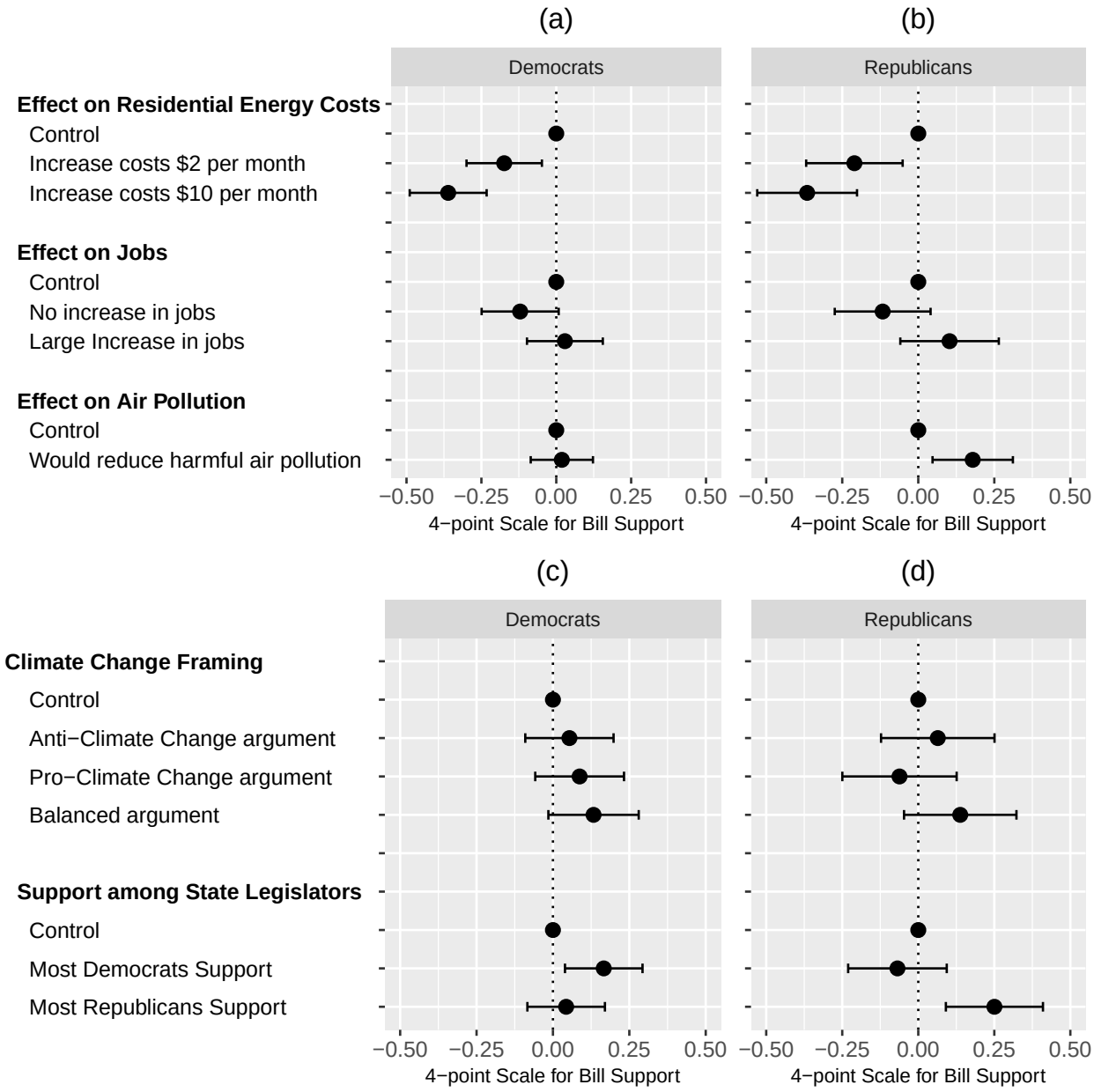

Figure 3: The effects of each treatment on Democratic and Republican respondents' support for a renewable portfolio standard in the respondent's state. Effects of policy design on a) Democrats and b) Republicans. Effects of framing on c) a Democrats, and d) Republicans. All results are plotted relative to the control group for each treatment. Error bars show 95% confidence intervals.

Public support will be necessary to maintain for several decades, as the electricity system is slowly transitioned away from fossil fuels.[30]

Methods

Estimating State-Level Opinion. Our estimates of state-level opinion about renewable energy policies are based on a question on a nationally representative sample of 56,200 Americans from the 2014 Cooperative Congressional Election Study [24]. The subjects for this study were recruited during the fall of 2014 and the survey was conducted via the Internet in October and November of 2014 by YouGov/Polimetrix of Palo Alto, CA. The full survey instrument is available at http://dx.doi.org/10.7910/DVN/XFXJVY.[24] This documentation also describes the methodology of the survey in more detail. The question that we used in our study asks whether respondent support: "Your state requiring the use of a minimum amount of renewable fuels (wind, solar, and hydroelectric) in the generation of electricity even if electricity prices increase a little?" We estimated the percentage of respondents in each state that supported this RPS policy. We weighted respondents using the weights provided in the survey in order to ensure that the sample is representative of the population at both the state and national levels. The survey includes more than 1000 respondents in many states and over 100 respondents in nearly all states. As a result, we were able to estimate state-level support for RPS policies relatively precisely.

Table 1: Comparison of SSI Sample to Census Targets

	Census Targets	SSI
Female	0.51	0.54
Black	0.13	0.11
High School Degree or less	0.41	0.36
Bachelors Degree or more	0.30	0.32
Age less than 44	0.48	0.53

Survey Experiment Sample. Our survey experiment about the design and messaging of RPS bills is based on a survey of the American public conducted via the Internet by Survey Sampling International in August 2016. This survey had a sample of 2,500 respondents. SSI recruits participants through various online communities, social networks, and website ads. SSI makes efforts to recruit hard-to-reach groups, such as ethnic minorities and seniors. These potential participants are then screened and invited into the panel. When deploying a particular survey, SSI randomly selects panel participants for survey invitations. We did not employ quotas but asked SSI to recruit a target population that matched the (18 and over) census population on education, gender, age, geography, and income (based on pre-measured profile characteristics of the respondents). The resulting sample is not a probability or representative sample, but is a diverse national sample. In order to further evaluate the representativeness of our sample, Table 1 compares the SSI sample to population targets from the Census. It indicates that the SSI sample closed matched census targets. The sample is slightly younger and more educated than the general population, but the differences are quite small in magnitude.

Survey Experiment Design. Our approach is similar to a conjoint-based experimental design, albeit without requiring respondents to choose among alternatives.[26] We use a

between subjects design, with each respondent receiving a series of statements about the bill on it. The experiment began with the following question wording: "Over the past decade, many state legislatures passed renewable energy laws. These laws require some of the state's electricity to come from wind, solar, or other renewable energy sources. During the next legislative session, imagine legislators may consider a new bill that would require [respondent's state] to meet 35% of its electricity needs with renewable energy sources by the year 2025. Where available, here are a couple details about the bill in [respondent's state]."

We then presented respondents with a variety of statements about this bill to test how the public would respond to various aspects of a bill [23]. We designed these treatments based on existing theories that suggest these cues and policy designs could be salient to public support for renewable energy technologies [7, 16, 18, 17], and because these issues often vary state by state.

First, we provided information on the likely private cost impacts if the renewable energy bill was passed. In one treated group, respondents were told the bill would likely add $10 per month to each resident's electricity bill. A second treated group was told the bill would likely add $2 per month to each resident's electricity bill. These two cost estimates are within the range of potential shorter and longer-term rate impacts, assuming residential consumers bear RPS policy costs.[27, 11] A third, control group was given no information on the bill's cost implications.

Other economic impacts, most notably employment effects, may also be a key factor underlying support for energy policy. To test these theories, we created two treatments. Some respondents were told that experts predict the bill would probably create several thousand jobs in their state. Other respondents were told that experts predicted the bill probably would not create many jobs in their state. In a control treatment, no information was provided about jobs.

Clean air is another proposed reason why people support renewable energy policy.[7] In one treatment, respondents were told that supporters of the bill argued the bill would reduce harmful air pollution in their state, including toxins like mercury. In a control treatment, no information was provided on air pollution.

By contrast, framing these policies around climate change may mean that citizens see RPS policies' benefits as more global than local, since citizens see climate change as a global problem.[7] To test these ideas, we designed three treatments that linked the bill to climate change and provided a cue on whether or not political actors thought climate change was occurring. Some respondents were told that the bill's supporters argue that climate change is a serious problem, and the bill would reduce greenhouse gas emissions that cause climate change. Other respondents were told that the bill's opponents argue that climate change is not a serious problem, and for this reason increasing renewable energy is not important. In a third treatment, both of these statements were shown together, essentially giving the respondent conflicting information on whether or not climate change was a serious problem. This treatment follows Aklin & Urpelainen [31]'s suggestion that framing studies should consider the role of both frames and counter frames. In a control condition no information about climate change was provided.

Finally, we examined how elite support could affect public support for an RPS. To examine the impact of elite support on opinions about RPS policies, we created two treated groups, providing information that either most Democrats or most Republicans in the state

legislature support these renewable energy requirements. This is a realistic statement, since past state RPS policies have often received support from both parties.[10, 32] The control group was shown no partisan prime. We did not test a bipartisan prime because we were interested in testing the theory of whether partisans respond to copartisans cues, not bipartisanship per se.

Regression and Subgroup Analysis. To estimate the average treatment effects of each treatment variable, we ran an ordinary least squares (OLS) regression that included all the treatments as shown in Equation 1.[26] Since multiple treatments were provided to the same respondent simultaneously, the assumption is that the treatment effects are independent. In other words, receiving one treatment should not affect the other treatments. Note also that, in a few cases, respondents would be in the control group for all five treatments and would therefore be provided no additional information about the bill. In the survey, respondents were asked basic demographic questions, including their ideology, 7-point partisan ID, age, gender, race and education. Given that the treatment was randomly assigned, the main results do not change if additional covariates collected in the survey, such as age, race, gender, education and party ID, are included in the model (Supplementary Note 2 and Supplementary Table 3). The results are also similar with ordinal probit and probit models (Supplementary Note 2 and Supplementary Tables 4 and 5). When examining partisan subgroups, we used a standard practice 7-point party ID scale, and pushed leaners toward their respective parties. We treated the middle category as 'true independents' and omitted them from the subgroup partisan analysis.

$$Y_i = \beta_0 + \beta_1 PARTISAN_i + \beta_2 COST_i + \beta_3 JOBS_i + \beta_4 AIRPOLL_i + \beta_5 CLIMATE_i + \epsilon_i \quad (1)$$

The results for our analysis of partisan subgroups also do not change if additional covariates, such as age, race, gender, and education, are included in the model (Supplementary Table 6).

Ethics Statement

The MIT Institutional Review Board (IRB) approved the survey experiment described in this article. Informed consent was obtained from all subjects.

Data Availability Statement

The datasets and replication code for this study are available in the Harvard Dataverse repository, http://dx.doi.org/10.7910/DVN/DL4JY8.[33]

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Author contributions

The authors contributed equally on all aspects of this article. Warshaw was the principle investigator on the grant from the MIT Energy Initiative that funded this research, and managed the survey experiment with SSI.

Competing interests

The authors have no competing financial interests.

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