

# Quota Sampling Using Facebook Advertisements Can Generate Nationally Representative Opinion Estimates

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## Abstract

Researchers in different social science disciplines have successfully used Facebook to recruit subjects for their studies. Such convenience samples, however, are not generally representative of the population. We develop and validate a new method to recruit respondents using quota sample through Facebook advertisements. To test the method, we used advertisements to quota sample 2,432 US respondents for a survey on climate change public opinion. Around the same time, we conducted a nationally representative survey asking identical questions using a high-quality probability sampled online panel survey. Results from the Facebook-sampled survey are similar to those from the online panel survey; furthermore, results from the Facebook-sampled survey approximate results from the American Community Survey (ACS) for a set of validation questions. These findings suggest that using Facebook to recruit respondents is a viable option for survey researchers wishing to approximate population-level public opinion.

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# 1 Introduction

Survey researchers have increasingly turned towards web-based survey tools like Amazon's Mechanical Turk and Google Consumer Surveys as cost-efficient methods to survey diverse target populations (Berinsky, Huber, and Lenz, 2012; Huff and Tingley, 2015; Santoso, Stein, and Stevenson, 2016). An emerging literature has also used Facebook to recruit respondents into research studies. One of the most successful applications of Facebook for subject recruitment is the myPersonality Project, which enrolled over 4 million Facebook users as subjects (Kosinski et al., 2015). Psychologists created a Facebook application that allowed users to take psychometric tests; they subsequently linked results from these tests to users' Facebook profiles. Using this recruitment tool, researchers were able to predict personal attributes and personality traits from users' social media behavior (Kosinski, Stillwell, and Graepel, 2013; Youyou, Kosinski, and Stillwell, 2015). Medical researchers have similarly used Facebook to recruit subjects from specific subpopulations, such as young adults who smoke cigarettes (Ramo and Prochaska, 2012; Ramo et al., 2014) or American women aged 35-49 (Kapp, Peters, and Oliver, 2013).

Within political science, researchers have used Facebook to recruit respondents in Brazil for survey experiments Samuels and Zucco (2013, 2014). The researchers posted advertisements that promised a free iPad for one subject randomly drawn from those who completed the survey. For a cost of \$1.86 per valid survey completion, the researchers were able to obtain responses from 3,286 subjects. Although the authors discussed the possibility of targeting specific demographics on Facebook, they only targeted users who were 18 and older (to comply with IRB ethical standards). Although the Facebook sample was less representative than a national sample the researchers obtained through a survey firm, the results of the survey experiments conducted on the Facebook sample yielded similar results, especially after weighting the responses through post-stratification. As Samuels and Zucco (2013) and Samuels and Zucco (2014) suggest, Facebook may be a cost-effective method to obtain quasi-representative samples of respondents, especially in countries where Mechanical Turk is not widely available.

In this research note, we extend an emerging literature that leverages Facebook as a sampling platform to test whether Facebook advertisement-based recruitment can efficiently generate public opinion estimates that approximate national averages. Our method exploits the recently updated Facebook Marketing API to semi-automate a quota sampling process. Through a proof-of-concept study on US climate opinions, we demonstrate that researchers can cost-effectively recruit respondents through quota sampling using Facebook advertisements. Results from the Facebook-sampled survey approximate results from a survey conducted by a reputable survey research firm, GfK, as well as results from the American

Community Survey (ACS). To accompany this research note, we are releasing an R package, `fbsample`, that automates the quota sampling process using the Facebook Marketing API.<sup>1</sup>

## 2 Methodology

In order to obtain the most representative sample given a constrained advertisement budget, we employ quota sampling to target a series of specific demographic groups. Convenience sampling methods that do not set demographic quotas will produce very non-representative samples. This is because Facebook’s marketing algorithm maximizes clicks on an advertisement by sending the advertisement to users who the algorithm predicts will click on the advertisement with high probability. All else equal, ads will be sent to users who are similar to those who had previously clicked on the advertisement. For instance, if many young white males clicked on an advertisement when it was first launched, Facebook will continue sending the advertisement to mostly young white males. Therefore public opinion scholars must establish demographic strata to sample to avoid “homogenization” of their sample.

Fortunately, the Facebook Marketing API also makes it relatively easy to target specific demographic subgroups. Prior to 2015, advertisers had to manually set up ads that target specific groups. However, with Facebook making its Marketing API publicly available in 2015, advertisers gained the ability to write programs to target thousands of pre-specified groups at once. Our current method exploits this capacity to quota sample many demographically diverse strata at once.

However, efforts to estimate national public opinion from Facebook quota samples depend on a series of assumptions, some of which may not hold in reality. Define  $R_i$  as whether member  $i$  of the population takes the survey,  $\mathbf{D}_i$  as the vector of respondent  $i$ ’s characteristics that researchers used to construct strata for quota sampling, and  $\mathbf{X}_i$  as the vector of respondent  $i$ ’s characteristics not used to construct strata but are measured in the survey. Furthermore, define  $Y_i$  as person  $i$ ’s response to a survey question.

**ASSUMPTION 1:**  $Y_i \perp R_i | \mathbf{D}_i = \mathbf{d}_i, \mathbf{X}_i = \mathbf{x}_i, \forall \mathbf{d}_i \in \text{Supp}(\mathbf{D}_i) \text{ and } \forall \mathbf{x}_i \in \text{Supp}(\mathbf{X}_i)$

**ASSUMPTION 2:**  $\Pr(R_i = 1 | \mathbf{D}_i = \mathbf{d}_i, \mathbf{X}_i = \mathbf{x}_i) > 0, \forall \mathbf{d}_i \in \text{Supp}(\mathbf{D}_i) \text{ and } \forall \mathbf{x}_i \in \text{Supp}(\mathbf{X}_i)$

Assumption 1 implies that conditional on strata and observed respondent characteristics, in expectation, responses of those who took the survey would be the same as those who did not take the survey. While this assumption might not hold in reality, the degree to which violations of Assumption 1 will bias efforts to use Facebook advertisements to estimate national public opinion is an empirical question

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<sup>1</sup>`fbsample` is available online at <https://github.com/13bzhang/fbsample>.

that this research note is designed to address.

Assumption 2 asserts that conditional on strata and observable characteristics, each person in the population has a non-zero probability of taking the survey. Obviously, not everyone in a given population has a Facebook account or uses Facebook regularly. According to a 2015 Pew study, 72 percent of American adult internet users use Facebook and 62 percent of the US adult population uses Facebook.<sup>2</sup> Even so, Facebook allows one to reach a far greater proportion of the US adult population than other ways researchers recruit convenience samples. For instance, researchers recruiting respondents using Mechanical Turk can only reach about 7,300 workers in any quarter year (Stewart et al., 2015).

### 3 Study Design

To demonstrate the validity of the quota sampling method described above, we conducted a study to compare the results of a quota-sampled Facebook survey with a high-quality probability-sampled GfK online panel survey. The two surveys, which shared 25 identical questions, were conducted a few months apart in 2016. Apart from the questions asking about respondent demographics, both surveys focused on attitudes towards climate change and support for policies to mitigate climate change. In addition, to validate the Facebook sample against the ACS, we asked three questions from the ACS about veteran status, home ownership, and country of birth.

The Facebook Marketing API allows researchers to write programs that target several thousand highly specific demographic groups at a time. Before the API was made public, interested parties needed to manually generate target groups one at a time. For our quota sampling, we generated 544 strata according to demographic characteristics (e.g., gender, age, race, level of education, and geographic region). Next, we assigned an advertisement budget to each stratum according to proportional allocation for most strata; we allocated greater budget to strata that contain very small sub-populations nationally. This oversample was necessary to generate a minimum number of respondents in these strata. Our advertisements informed respondents that by taking the survey they could see how their views on climate change compared to the views of other Americans; no rewards were promised. To maximize viewership, we promoted the advertisements on all Facebook platforms (news feed, right column advertisement space, etc.), with the exception of Instagram.

During the respondent recruitment period, we activated the advertisements in the morning and deactivated them after 8 p.m. EST. After each day of recruitment, we removed ads for strata whose quotas

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<sup>2</sup>Duggan, Maeve. "The Demographics of Social Media Users." Pew Research Center, 2015. <http://www.pewinternet.org/2015/08/19/the-demographics-of-social-media-users/>

have been filled. This method of quota sampling allowed some strata to be overfilled, wasting some advertisement budget.<sup>3</sup>

Over a period of two weeks in July 2016, we recruited 2,432 respondents who completed the survey. At the end of the recruitment period, we filled or overfilled 218 strata, partially filled 61 strata, and failed to recruit anyone for 157 strata. On average, the Facebook survey cost \$4.27 per complete.

Our probability-sampled online panel study was conducted in March 2016. This survey sampled 2,459 respondents with 1,346 completions for a completion rate of 54.7%.<sup>4</sup> This study used GfK's Knowledge Panel, with a household recruitment rate for our survey of 12.3% (AAPOR Response Rate 3). Overall, our online panel responses cost nearly six times as much as our Facebook user responses.

## 4 Results

Results from the Facebook survey are reasonably similar to results from the online panel survey and the ACS even without weighting. For questions where the Facebook and online panel survey results differed, the Facebook respondents produced answers indicating greater concern for climate change.

Table 1 displays the summary statistics for the demographic groups in the survey. Contrasted with the GfK sample, the Facebook sample is younger, less white, and more liberal. To make both surveys more nationally representative, we used inverse probability weighting to weight each sample to the March 2016 Current Population Survey (CPS). We combine each sample and the CPS, then we use logistic regression to estimate the probability of being included in the sample. Covariates used in our propensity score model include gender, age group, level of education, race, geographic region, and whether the respondents lived in a metropolitan area. The final weights are the inverse of the estimated probabilities normalized such that the sum of each sample's weights equals the sample size.<sup>5</sup> As Figure 1 demonstrates, the weighted demographics summary statistics of the two surveys are very similar except for political party; the Facebook sample contains a greater proportion of Independents and a smaller proportion of Republicans compared with the online panel sample.

The results for the eight questions about climate change are presented in Figure 1. For the unweighted results, the mean difference is 4.9 percentage points with a standard deviation of 4.1 percentage points. In terms of these unweighted results, the Facebook-sampled respondents expressed slightly

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<sup>3</sup>To address this problem, researchers could connect the the Facebook Marketing API with their survey software API so that advertisements will automatically shut down for strata that have been filled.

<sup>4</sup>GfK dropped cases where more than half the survey questions were left blank and/or where respondents completed the survey in under 7 minutes, generating a final 1,317 final observations.

<sup>5</sup>The correlation between the inverse probability weights for the GfK sample and the weights supplied by GfK is 0.64.

Table 1: Summary Statistics of Survey Respondents

	GfK	Facebook	GfK	Facebook
Weighted	No	No	Yes	Yes
<i>N</i>	1317	2432	1317	2432
Prop. Male	0.497	0.479	0.474	0.478
Prop. Age 18-24	0.076	0.186	0.119	0.119
Prop. Age 25-34	0.135	0.160	0.171	0.196
Prop. Age 35-44	0.140	0.156	0.165	0.170
Prop. Age 45-64	0.391	0.288	0.352	0.331
Prop. Age 65 and Above	0.257	0.210	0.193	0.184
Prop. with College Degree	0.206	0.225	0.197	0.186
Prop. with Graduate Degree	0.159	0.159	0.113	0.117
Prop. Hispanic	0.108	0.130	0.146	0.133
Prop. Black Only	0.090	0.061	0.112	0.108
Prop. White Only	0.743	0.617	0.657	0.679
Prop. Democrat	0.425	0.421	0.435	0.412
Prop. Republican	0.360	0.269	0.326	0.267
Prop. Independent	0.105	0.179	0.102	0.175
Mean Political Ideology	3.055	2.819	3.040	2.808
Prop. Registered to Vote	0.834	0.812	0.790	0.805

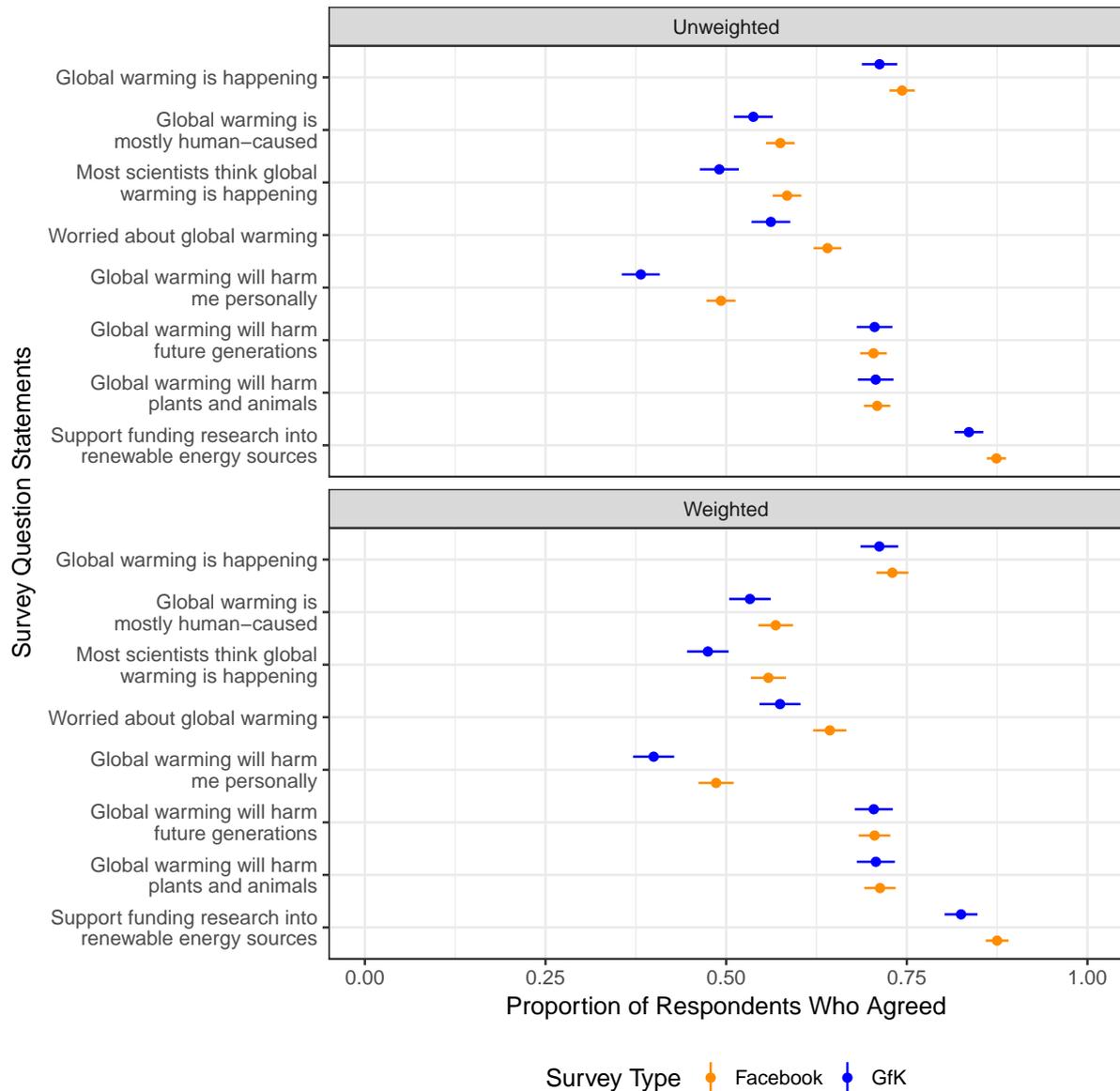
Respondents who indicated they “lean Democrat” are counted as Democrats; respondents who indicated they “lean Republican” are counted as Republicans. Political ideology is measured using a 5 point scale where 1 is very liberal and 5 is very conservative.

less skepticism about climate change, greater concern about climate change, and greater support for policies that mitigate climate change. After weighting both the Facebook survey and the online panel survey to the CPS, the mean difference in responses is 4.4 percentage points with a standard deviation of 3.4 percentage points.

One reason that the Facebook-sampled respondents may be more concerned about climate change is that our advertisement explicitly contained language about climate change and included a photo of the Earth. Respondents who are pro-climate action might be more motivated to click on the advertisement than those who are unconcerned about climate change. A breakdown of the survey results by partisanship revealed that Democrats, Republicans, and Independents within the Facebook survey provided similar responses to Democrats, Republicans, and Independents in the online panel survey, respectively. However, respondents in the Facebook survey who said they are uninterested in politics were significantly more pro-climate action than their counterparts in the online panel survey. This difference between the two samples suggests that within each stratum, Facebook users might not be as if randomly sorting into the recruitment sample. One possible strategy to avoid self-sorting that affects survey results is to create ads that do not discuss the content of the survey being advertised, although this strategy will

require careful attention to advertisement wording and design.<sup>6</sup>

Figure 1: Comparing Facebook Survey with GfK Survey: Climate Change Public Opinion



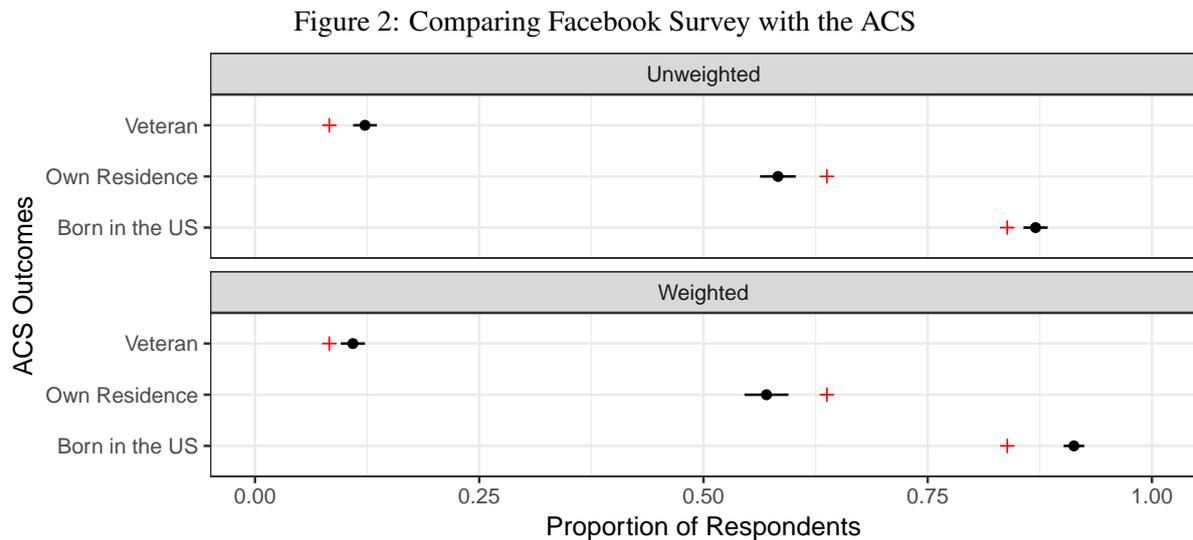
The coefficient plots above report the point estimate and the 95 percent confidence interval for each outcome measure. The confidence intervals are calculated from heteroscedasticity-consistent standard errors.

As a further robustness check, we compare three results from the Facebook survey with those from the 2011-2015 ACS Five-Year Estimates. Specifically, we estimated the proportions of adult Americans who are veterans, who own their residences, or who were born in the US using the Facebook responses. The questions respondents received were identical to the ones asked by the ACS. As Figure 2 demonstrates, the Facebook survey overestimated the proportion who are veterans and were born in the US and

<sup>6</sup>During the A/B testing phase of this pilot study, we launched ads that advertised a generic public opinion survey. These ads received very few clicks. We decided to instead launch the ads that contained information about climate change to generate a sufficient number of clicks.

underestimated the proportion who own their residences.<sup>7</sup>

Although it remains unclear why the Facebook survey would overestimate the proportion who are veterans, there is likely a simple reason why our recruitment method overestimated those who were born in the US. The ACS was available in many languages while our Facebook survey was only available in English; as a result, Facebook users who did not understand English – who are also more likely to be born outside the US – could not participate in the survey. In contrast, the underestimation of the proportion who are homeowners could be attributed to the fact that the Facebook sample contained disproportionately more young adults, a group who are less likely to be homeowners. However, despite these differences at the margins, the results of the Facebook survey resembled the results of the online panel survey and the ACS. Differences in responses could be explained by the younger and more pro-climate action subjects who constituted the Facebook sample.



In the coefficient plot above, the red crosses represents the ACS estimates and the black dots represent the Facebook Survey estimates. For the Facebook Survey estimates, the coefficient plots also report the 95 percent confidence interval for each outcome measure. The confidence intervals are calculated from heteroscedasticity-consistent standard errors.

## 5 Conclusion

This study produced valuable lessons for best practices in quota sampling using Facebook advertisements. Quota-sampling using Facebook advertisements can generate results that approximate high quality probability-based national opinion surveys. Further improvements to our proposed method would

<sup>7</sup>The home ownership question was also included in the GfK survey. The weighted estimated proportion who own their residences using the online panel survey is 4.5 percentage points higher than the ACS estimate. Compare this with the weighted estimate using the Facebook survey that is 6.7 percentage points lower than the ACS estimate.

result from systematic attention to the factors that drive Facebook users to click on advertisements. We highlight a number of considerations for future researchers. First, researchers might inadvertently recruit particular types of respondents by advertising the content of the survey. This form of self-selection bias may not be eliminated by strata targeting or by conditioning on observable demographic characteristics. To avoid this problem, researchers can advertise their survey using vague language without revealing its core content. Additional design effort may be required then, however, to persuade users to click on such ads.

Second, researchers might consider making their survey available in multiple languages so that a greater percentage of Facebook users within a population can participate. For instance, translating the survey and the accompanying advertisement into Spanish would increase the number of Hispanic users who could participate in the study.

Future researchers could also further reduce bias in their estimates by measuring other characteristics of the respondents and using those characteristics to weight their Facebook-sampled survey. In particular, we suggest the utility of focusing on obtaining respondent characteristics that are not available through Facebook, such as political party identification, to improve the quality of re-weighting efforts.<sup>8</sup>

More broadly, our findings suggest that using Facebook to recruit respondents is a viable option for survey researchers seeking to approximate population norms at significantly lower cost. It may also be particularly useful for targeted samples of geographic or demographic subpopulations, for which national panels may be unable to obtain representative samples.

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<sup>8</sup>It should be noted that Facebook has recently made possible for advertisers to target users by users' political ideology. Users' ideologies are imputed from their social media behavior (Bond and Messing, 2015). Therefore, it is feasible for researchers to construct strata that include political ideology as a demographics variable.

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## Online Supplementary Information

### Further Information on Data and Procedures

Information in this subsection supplements that provided in the Study Design section of the manuscript. The population under study for both the Facebook and GfK surveys are residents of the United States who are age 18 or older. We excluded participants with IP addresses outside the United States.

The recruitment process for Facebook user respondents is described in the Study Design section of the manuscript. The GfK survey was conducted March 18-31, 2016. All questionnaires were self-administered by respondents in a web-based environment. The sample was drawn from GfK's KnowledgePanel, an online panel of members drawn using probability sampling methods. Prospective members are recruited using a combination of random digit dial and address-based sampling techniques that cover virtually all (non-institutional) resident phone numbers and addresses in the United States. Those contacted who would choose to join the panel but do not have access to the Internet are loaned computers and given Internet access so they may participate. The sample, therefore, includes a representative cross-section of American adults – irrespective of whether they have Internet access or use only a cell phone.

### Additional Data Tables

The following tables report the numerical results illustrated by the manuscript's figures. Heteroscedasticity-consistent standard errors are reported in parentheses following the estimated population proportions.

Table 2: Comparing Facebook Survey with GfK Survey: Climate Change Public Opinion Unweighted Results

Survey Items	Facebook	GfK
Global warming is happening	0.743 (0.009)	0.712 (0.012)
Global warming is mostly human-caused	0.575 (0.010)	0.538 (0.014)
Most scientists think global warming is happening	0.584 (0.010)	0.491 (0.014)
Worried about global warming	0.640 (0.010)	0.562 (0.014)
Global warming will harm me personally	0.493 (0.010)	0.382 (0.013)
Global warming will harm future generations	0.704 (0.009)	0.705 (0.013)
Global warming will harm plants and animals	0.709 (0.009)	0.707 (0.013)
Support funding research into renewable energy sources	0.874 (0.007)	0.836 (0.010)

Table 3: Comparing Facebook Survey with GfK Survey: Climate Change Public Opinion Weighted Results

Survey Items	FB IPW	GfK IPW	GfK-supplied Weights
Global warming is happening	0.730 (0.011)	0.712 (0.013)	0.707 (0.015)
Global warming is mostly human-caused	0.569 (0.012)	0.533 (0.015)	0.534 (0.016)
Most scientists think global warming is happening	0.558 (0.012)	0.475 (0.015)	0.476 (0.016)
Worried about global warming	0.643 (0.012)	0.575 (0.014)	0.576 (0.016)
Global warming will harm me personally	0.486 (0.012)	0.400 (0.015)	0.402 (0.016)
Global warming will harm future generations	0.705 (0.011)	0.704 (0.013)	0.698 (0.015)
Global warming will harm plants and animals	0.713 (0.011)	0.707 (0.013)	0.703 (0.015)
Support funding research into renewable energy sources	0.875 (0.008)	0.825 (0.012)	0.820 (0.013)

Columns 2 and 3 show the weighted survey results using the inverse probability weights generated by the researchers. Column 4 shows the the weighted survey results using the weights supplied by GfK.

Table 4: Comparing Facebook Survey with the the ACS

Survey Items	Facebook (Unweighted)	Facebook (Weighted)	ACS
Veteran	0.123 (0.007)	0.109 (0.007)	0.083
Own Residence	0.583 (0.010)	0.570 (0.012)	0.638
Born in the US	0.870 (0.007)	0.913 (0.006)	0.839

## **Text of Survey**

The text of the survey is included below.

### **x65**

Recently, you may have noticed that global warming has been getting some attention in the news. Global warming refers to the idea that the world's average temperature has been increasing over the past 150 years, may be increasing more in the future, and that the world's climate may change as a result.

What do you think: Do you think that global warming is happening?

- Yes
- No
- Don't know

### **x67**

Assuming global warming is happening, do you think it is...

- Caused mostly by human activities
- Caused mostly by natural changes in the environment
- Other (Please specify) [textbox]

### **x73**

Which comes closest to your own view?

- Most scientists think global warming is not happening
- There is a lot of disagreement among scientists about whether or not global warming is happening
- Most scientists think global warming is happening
- Don't know enough to say

### **x78**

How worried are you about global warming?

- Very worried
- Somewhat worried
- Not very worried
- Not at all worried

**x79**

How much do you think global warming will harm you personally?

- A great deal
- A moderate amount
- Only a little
- Not at all
- Don't know

**x85**

How much do you think global warming will harm future generations of people?

- A great deal
- A moderate amount
- Only a little
- Not at all
- Don't know

**x86**

How much do you think global warming will harm plant and animal species?

- A great deal
- A moderate amount
- Only a little
- Not at all
- Don't know

**x137**

How much do you support or oppose the following policy?

Fund more research into renewable energy sources, such as solar and wind power.

- Strongly support
- Somewhat support
- Somewhat oppose
- Strongly oppose

**Gender**

Are you...?

- Male
- Female

**Age**

What is your age?

- 18-24
- 25-34
- 35-44
- 45-64
- 65 or older

**State**

What U.S. State do you live in? Or do you live in a U.S. Territory or other country?  
Please scroll down to select.

**Hispanic**

Do you have a Hispanic, Latino, or Spanish family heritage?

- Yes
- No

**Race**

What best describes your race?

- White or Caucasian
- Black or African-American
- Asian or Asian-American
- A Different Race
- 2 or More Races

**Zip Code**

Climate and weather are different in different parts of the country. Please enter your five-digit zip code to help us understand what the weather is like in your area.

[Textbox]

## **Education**

What is the highest level of education you have completed?

- Did not graduate high school
- High school graduate, GED, or alternative
- Some college, or associates degree
- Bachelor's (college) degree or equivalent
- Graduate or professional degree (e.g., Master's Degree, M.D., Ph.D., J.D., MBA)

## **Veteran**

Have you ever served on active duty in the U.S. Armed Forces, Reserves, or National Guard?

- I never served in the military
- I served only on active duty for training in the Reserves or National Guard
- I am now on active duty
- I was on active duty in the past, but not now

## **Born in the US**

Were you born in the United States, or not?

- Yes, I was born in the U.S.
- No, I was not born in the U.S.

## **Own Residence**

Do you own or rent your current residence?

- I or someone in my household own my current residence with a mortgage or a loan
- I or someone in my household own my current residence free and clear
- I rent my current residence
- I live in my current residence without payment of rent

### **Registered to Vote**

Are you currently registered to vote, or not?

- Registered
- Not registered
- Don't know
- Prefer not to answer

### **Party ID**

Generally speaking, do you think of yourself as a...

- Republican
- Democrat
- Independent
- Other
- No party / not interested in politics

If respondents selected "Independent" or "Other", they are asked the following.  
Do you think of yourself closer to the...

- Republican Party
- Democratic Party
- Neither

### **PID5**

In general, do you think of yourself as...

- Very liberal
- Somewhat liberal
- Moderate, middle of the road
- Somewhat conservative
- Very conservative

## Coding for Survey Items

The following tables describe how we coded the outcome variables analyzed in the manuscript.

Table 5: Climate Change Public Opinion Questions

<b>Survey Items</b>	<b>Coded “Agree” for the Following Responses to Survey Questions</b>
Global warming is happening	x65: Yes
Global warming is mostly human-caused	x67: Caused mostly by human activities
Most scientists think global warming is happening	x73: Most scientists think global warming is happening
Worried about global warming	x78: Somewhat worried; Very worried
Global warming will harm me personally	x79: A great deal; A moderate amount
Global warming will harm future generations	x85: A great deal; A moderate amount
Global warming will harm plants and animals	x86: A great deal; A moderate amount
Support funding research into renewable energy sources	x137: Somewhat support; Strongly support

Table 6: ACS Demographics Questions

<b>Survey Item</b>	<b>Coded “Yes” for the Following Responses to Survey Questions</b>
Veteran	Veteran: I was on active duty in the past, but not now
Own Residence	Own Residence: I or someone in my household own my current residence with a mortgage or a loan; I or someone in my household own my current residence free and clear
Born in the US	Born in US: Yes, I was born in the U.S.