ENERGY CONSERVATION "NUDGES" AND ENVIRONMENTALIST IDEOLOGY: EVIDENCE FROM A RANDOMIZED RESIDENTIAL ELECTRICITY FIELD EXPERIMENT

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Abstract
"Nudges" are being widely promoted to encourage energy conservation. We show that the popular electricity conservation "nudge" of providing feedback to households on own and peers' home electricity usage in a home electricity report is two to four times more effective with political liberals than with conservatives. Political conservatives are more likely than liberals to opt out of receiving the home electricity report and to report disliking the report. Our results suggest that energy conservation nudges need to be targeted to be most effective. (JEL: Q41, D03, D72)

1. Introduction

Europe, especially Scandinavia, has high taxes on electricity and gasoline to encourage conservation and counter global warming. Taxes in Denmark represent more than half of the cost of electricity to consumers.[1] In contrast, the United States has low taxes and little political will to sacrifice for the sake of conservation. Congressional voting patterns highlight that conservative Representatives are highly unlikely to vote for carbon mitigation legislation (Cragg et al. 2013).

Facing political gridlock in the Congress and concerned about the challenge of climate change, an ongoing policy agenda is seeking out alternative strategies for encouraging conservation. Recent psychology research suggests an alternative tool for changing household behavior is to focus on well crafted messages offering peer comparisons (see Griskevicius, Cialdini, and Goldstein 2008). Robert Cialdini and his coauthors have conducted a series of field experiments that have demonstrated that low-cost persuasion strategies or "nudges" can change an individual's behavior by making

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1. See Eurostat News Release, 75/2010, 28 May 2010. http://epp.eurostat.ec.europa.eu/cache/ITY_PUBLIC/8-28052010-AP/EN/8-28052010-AP-EN.PDF

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him aware of the actions of others who have been in a similar situation (Goldstein et al. 2008; Schultz et al. 2007). Nudges may be a low cost strategy for encouraging energy conservation (Allcott and Mullainathan 2010; Thaler and Sunstein 2008).[2]

We posit that liberal/environmentalists are more likely to respond to energy conservation nudges. A series of recent empirical papers has documented that environmentalists are more likely to engage in "voluntary restraint" than the average person (Kotchen and Moore 2008). Those who vote in favor of "green policies" and register for liberal/environmentalist political parties are more likely to have a smaller carbon footprint and to purchase green products such as the Toyota Prius (Kahn 2007, Kahn and Morris 2009). Such environmentalists consciously avoid free riding and voluntarily restrain their consumption of goods and services that generate a negative externality.

Our evidence on the role of ideology in energy conservation "nudges" comes from a randomized field experiment carried out by a western utility district in which we can observe a household's ideology (an unobservable in prior studies), its socioeconomic and demographic characteristics, and its behavioral responses. Starting in Spring 2008, this utility has been sending households in the treatment group a Home Energy Report (HER). The report provides household specific information on own monthly electricity usage over time and relative to neighbors' usage over the same time period. The report provides energy saving tips. To examine the role that political ideology and environmentalism play in determining how randomly selected households respond to these reports, we have collected data on the customer's political party of registration, household donations to environmental organizations and household participation in renewable energy programs, and data on the characteristics of the local residential communities where the households live. Households who are registered in liberal political parties and who live in residential communities with a large liberal share and who have previously signed up for energy from renewable resources and donate to environmental causes are arguably environmentalists. Our focus on ideology, an unobservable in previous studies, distinguishes our work from other research (e.g. Allcott 2011; Ayres, Raseman, and Shih 2009).

We find that the effectiveness of energy conservation "nudges" depends on an individual's ideology. In the United States, Democrat, Peace and Freedom, and Green party members (liberals in the US terminology) are more likely to vote for environmentalist causes than Republican, American Party, or Libertarian party members (conservatives in the US terminology). We measure ideology not just with registered political party, but also with indicators of living in a liberal or conservative community and willingness to pay for energy generated from renewable resources and to donate to environmental organizations. Although liberals and environmentalists are more energy efficient than conservatives (Costa and Kahn 2010), thus making it harder

2. In the United Kingdom, where electricity taxes are low, David Cameron has touted the behavioral transformations of putting "the typical electricity bill for a house like theirs in a neighborhood like theirs" in front of households. Speech of 13 June, 2008. http://www.aletmanski.com/files/davidcameron-powerofsocial-innovation.doc

for them to reduce consumption further, we find that liberals and environmentalists are more responsive to these nudges than conservatives.

We find that among political liberals who purchase electricity from renewable resources, who donate to environmental causes, and who live in a census block group where the share of liberals is in the top 75th percentile, receiving a HER led to reductions in electricity usage of 3.6%. In contrast, among political conservatives who do not pay for renewable electricity, who do not donate to environmental groups, and who live in a census block group where the share of liberals is in the bottom 25th percentile, receiving a HER led to reductions in electricity usage of 1.1%. Liberals are more likely to turn down the air-conditioning in the summer in response to the HER report. Political liberals were 15% less likely to opt out of receiving the report and, in a survey, political liberals are also less likely than conservatives to state that the reports were useless and to report disliking them.

By documenting the role that ideology plays in determining the effectiveness of a specific "nudge", this paper contributes to the growing literature on the consequences of political ideology. Much of this work has focused on the role of political ideology in shaping preferences for redistribution (e.g. Piketty 1995). Our work focuses on the role of political ideology in shaping responses to non-market mechanisms designed to reduce consumption. Recent work on the determinants of political ideology has examined the causal role of the media (DellaVigna and Kaplan 2007), property rights (Di Tella, Galiani, and Schargrodsky 2007), and historical circumstances (Alesina and Fuchs-Schundeln 2007; Giuliano and Spilimbergo 2009) in shaping a person's ideological outlook. Both social psychologists and economists have argued that beliefs on how society and the economy work predominately are formed at ages 18–25 (see Giuliano and Spilimbergo 2009). In this study, we will take as given that a household either is or is not a liberal/environmentalist and we will study how these political and social views influence household response to the same randomized treatment.

2. The Energy Conservation "Nudge"

The "nudge" that the electric utility company sends to treatment households in an ongoing randomized experiment to encourage reductions in electricity consumption is a two-page HER (see the Appendix for a sample). Similar reports have been used by other utilities in the United States. The front page compares the electricity consumption of the household with all neighbors with similar size homes and heat type and with neighbors who are in the bottom 20th percentile of electricity usage. The back page compares the household's electricity usage in the current month relative to the same time month in the prior year and awards green stars in every month the household consumed less relative to the same month in the past year (panel not shown in the Appendix because it is not publicly available). It also provides three tips for saving energy, such as turning down the thermostat when using an electric blanket or purchasing an Energy Star durable, and indicates the dollar amount in energy savings per year (shown in the Appendix).

Each report contains two pieces of information: the household's absolute level of consumption and how its consumption compares with that of 100 neighbors living in similar-sized homes. We also know whether a household in the treatment group received a message of "great", "good", or "room for improvement" in the first report. As we discuss in the Online Appendix, we use this information to implement a regression discontinuity design to test whether the change in electricity consumption for the treatment group differs depending on the normative message that the household receives in the first report.[3]

2.1. The HER Experiment

Between March 14 and May 9 2008, the electric utility sent the first Home Electricity Reports to a treatment group of approximately 35,000 households. By April 1, 43% of all treatment households had received the report and by April 15 the figure was 62%. Households are still receiving the report, either on a quarterly or monthly basis. A control group of roughly 49,000 households have never received a HER.

The HER experiment selected households from 85 census tracts with a high density of single-family homes (see ADM Associates 2009). Both treatment and control households had to have a current account with the electric utility that had been active for at least one year, could not be living in apartment buildings, and had to be living in a house with square footage between 250 and 99,998 square feet. Groups of contiguous census blocks were randomly assigned to either the treatment or control group. A "block batch" of five contiguous census blocks was randomly assigned to the treatment group and then a contiguous census block batch was assigned to the control group. The process continued until roughly 35,000 households were assigned to both the treatment and control groups. The remaining census blocks (about 14,000 homes) were assigned to the control group. Contiguous block groups were used because the implementation contractor, Positive Energy (now OPOWER), believed that increased communication among people receiving the HERs in the same community would lead to greater energy savings.[4]

Allcott (2011), Ayers, Raseman, and Shih (2009), and Schultz et al. (2007) found that providing feedback to customers on home electricity and natural gas usage with a focus on peer comparisons decreased consumption by 1% to 2%, potentially saving 110 million kWh per year if feedback were provided to all of the utility's customers (Ayers, Raseman, and Shih 2009). Additional evidence that social incentives can make a difference comes from California's 2001 media campaign to promote voluntary conservation after rolling blackouts in 2000 and early 2001. Consumption in San Diego

3. We thank a reviewer for suggesting this research strategy.

4. In a 2009 Home Energy Use Survey conducted by the electric utility, households in the control group were more likely to report talking to friends and neighbors about their electricity bill than households in the treatment group, suggesting that receiving the HER did not inspire discussion and that any positive peer effects operate through implicit social pressure.

declined by 7% during the initial two phases of the campaign, before rebounding (Reiss and White 2008).

3. Why Could Ideology Mediate the Response to this Nudge?

Within a household production framework, a household values electricity as an input in producing comfort (e.g. indoor temperature) and leisure and household production activities. Total household electricity consumption in any given period is the sum of electricity used in each of these activities. A household's total electricity consumption depends on choices over (1) the attributes of the house, such as size; (2) the attributes of appliances; and (3) the intensity of utilization of appliances for leisure and household activities, indoor temperature control and illumination. These choices, in turn, depend on climate, prices and personal attributes, including ideology.

We view environmental ideology as a set of prior beliefs including those about the importance of energy conservation The ideological divide on environmental issues between Democrats and Republicans could affect how a household responds to an energy conservation "nudge". In the United States, conservatives consistently oppose environmental regulation and energy policies intended to further environmental aims, as seen in polling data on the belief in climate change (Dunlap and McCright 2008) and Congressional voting patterns (Cragg et al. 2013). Dunlap and McCright (2008) report that in 2008 there was 34 percentage point gap between Democrats and Republicans in their agreement with a statement that the effects of global warming have already begun, up from a four percentage point gap in 1997. The 2008 National Environmental Scorecard of the League of Conservation Voters gives the House Democratic leadership a score of 95 (out of a best score of 100) and the Republican leadership a score of 3.[5] A 2009 Pew survey found a 23 percentage gap between Democrat and Republican agreement with the statement that people should be willing to pay higher prices to protect the environment. Republicans and Democrats respond differently to "carbon offsets" versus "carbon tax" (Hardistry, Johnson, and Weber 2010), suggesting that ideology moderates how individuals think of key words.

European studies have highlighted the role that environmental ideology plays in determining the willingness to take voluntary actions to mitigate one's carbon externality and the willingness to pay to purchase a "green product". Thalmann (2004) and Halbheer, Niggli, and Schmutzler (2006) document that voters who are left-of-center or who are environmentalists were more likely to vote for Swiss environmental referenda. Brounen and Kok (2011) found that the price premium for residential homes that are certified as highly energy efficient in Holland is higher in "green" communities, that is communities where the Green Party and the Party for the Animals had received a larger fraction of the vote.

Given this background, there are two main hypotheses that can be tested. Many households will read the report and respond to it for non-ideological reasons, such

5. See http://www.people-press.org/2009/05/21/section-9-the-environment-and-the-economy/

as wanting to lower their bill. These households, regardless of ideology, may reduce their consumption. The response of liberals is ambiguous. Liberals may reduce their consumption by more than conservatives because of their ideology and have been observed to consume less electricity (Kotchen and Moore 2008; Costa and Kahn 2010). However, because they have already invested more time and effort in monitoring their electricity bills and in engaging in voluntary restraint (i.e. lowering the air-conditioner in the summer), their response could be lower than that of conservatives. Secondly, and more controversially, it is possible that anti-environmentalist conservatives who receive a green looking report and learn that they consume more than their peers may refuse to decrease their consumption or even *increase* their consumption in an act of defiance. People find information more reliable when it conforms to their strong prior beliefs (e.g. Lord, Ross, and Leper 1979; Miller et al. 1993; Munro and Ditto 1997; Gentzkow and Shapiro 2006, 2010) and are influenced mainly by those in their network (Murphy and Shleifer 2004).

4. Data

Our primary data set consists of residential billing data from January 2007 to October 2009. These data provide us with information on kilowatt hours purchased per billing cycle, the length of the billing cycle (measured in days), whether the house uses electric heat, and whether the household is enrolled in the electric utility's program to purchase energy from renewable sources. We link each billing cycle to the mean temperature in that billing cycle.[6]

We link the billing data to the treatment and control data which contain information on when the household began to receive the HERs, as well as information on square footage of the house, information on whether the home heats with electricity or natural gas, and the age of the house. We cannot match 1,976 observations in the pilot and control data to the residential billing data. In our final data set, the treatment and control data therefore contain 81,722, with 48,058 households in the control group. Among the households in the treatment group, 24,028 received a monthly report and 9,636 received a quarterly report.

We merge individual voter registration and marketing data for March 2009 to our data set.[7] For registered voters we know party affiliation, and whether the individual donates to environmental organizations. We were able to link half of our sample to the voter registration data. We linked either the person whose name was on the utility bill or the first person on the utility bill.[8] The individuals we could not link were living in smaller households and in census block groups with a low proportion of the college-educated, were more likely to receive a subsidy for electricity because of their

6. Two different households in the same calendar year and same month who are on different billing cycles will face *different* climate conditions.
7. We purchased the data from www.aristotle.com.
8. Only 5% of households were "mixed" between conservatives and liberals.

low income, and were more likely to have a household head above age 60.[9] We also merge to these data, by the census block group, the share of registered voters who were liberal (Democrat, Green, or Peace and Freedom) in 2000 and the share of the college-educated in the block group. We expect that environmentalists are more likely to live in liberal, educated communities (Kahn 2007).

We have access to two revealed preference measures of a household's environmentalism. From the data base with voter registration information, we know whether a household has donated money to an environmental group. We also know whether the household has signed up for the company's renewable power program prior to the treatment. This is the electric utility's major program to increase the share of its customers who have signed up for renewable energy. Each household decides whether to opt in and pay a fixed cost of $3 a month to have 50% of its power generated by renewables or $6 a month to have 100% of its power generated by renewables.[10]

We also have access to an ancillary data set which we use to examine household attitudes about the HER by ideology. In 2009 the electric utility company surveyed 1,375 households who received the HER, asking them questions about the HER report. We restrict this sample to households for whom we have information on age and the fraction of liberals in the block group and to households who were not in minor parties we could not classify as liberal or conservatives. This leaves us with 1,061 observations in this ancillary data set.

Table 1 shows that the treatment and control groups are roughly representative of all homeowners in the county in terms of household and neighborhood characteristics. But, there are some clear differences. The treatment and control groups consume roughly 10% more electricity than the average county homeowner as of 2007 (before the experiment). Relative to the average homeowner, the experiment homes are older and more likely to be electric homes. The households in the experiment group are roughly 10% richer than the average county homeowner.[11] The geographical areas included in the experiment have a higher share of college graduates than the average county home owner's community.

The randomization of the HER across blocks was effective. Ayers, Raseman, and Shih (2009) reported that controlling for house characteristics, household demographics, and the number of cooling degree days and heating degree days, there was no systematic difference in energy usage between treatment and control groups prior to the treatment (also see Table 1 where we report no systematic differences between treatment and control groups adjusting for block batch group correlation).

9. Relative to all homeowners in the same county these individuals were also more likely to be of Asian or other ancestry rather than of European ancestry, but were less likely to be Spanish speaking. They were also lower income.

10. The collected revenue is used by the electric utility to purchase and produce power from wind, water, and Sun.

11. Household income is available from credit bureau data.

TABLE 1. Summary statistics, all homeowners, control and treatment group.

	All Home Owners		Control Group		Treatment Group	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Avg. Daily Electricity (kWh) in 2007	27.930	17.710	31.051	15.473	30.801	14.727
Household Size	2.111	1.159	2.111	1.136	2.103	1.137
Age of Head	56.582	14.967	56.941	14.952	56.594	15.085
Household Income	66,484.710	43,252.950	74,826.920	41,364.120	74,312.590	41,546.370
Home Square Footage	1,709.447	682.611	1,720.876	602.081	1706.109	578.287
Home Year Built	1,976.764	20.619	1,971.176	18.377	1972.618	18.547
Block Group% College	0.283	0.162	0.364	0.158	0.363	0.162
Block Group% Liberal	0.460	0.105	0.436	0.098	0.438	0.097
Registered as						
Republican, American, Libertarian	0.412	0.492	0.447	0.497	0.438	0.496
Democrat, Green, Peace and Freedom	0.461	0.498	0.439	0.496	0.449	0.497
No party	0.124	0.330	0.112	0.316	0.112	0.315
Other	0.002	0.045	0.002	0.046	0.002	0.043
Not registered	0.474	0.499	0.425	0.494	0.430	0.495
Donates to Environmental Causes	0.082	0.275	0.099	0.299	0.097	0.296
Electric Heat Home	0.165	0.371	0.246	0.431	0.264	0.441
Pays for Renewable Energy	0.088	0.283	0.104	0.305	0.103	0.304
Observations	285,717		48,058		33,664	

Note: All variables listed after the block group variables are dummy variables. The treatment and controls are not statistically significant after adjusting for clustering at the block batch level. Data on all homeowners comes from the records of the utility company and includes households in both the treatment and control groups.

TABLE 2. Summary statistics by political party registration.

	Conservatives		Liberals	
	Mean	S.D.	Mean	S.D.
Fraction in Treatment Group	0.406	0.491	0.416	0.493
Avg. Daily Electricity (kWh)	33.952	16.236	29.551***	14.248
Household Size	2.352	1.192	2.096***	1.099
Age of Head	58.490	14.104	59.199***	13.413
Household Income	84279.550	43711.440	74806.960***	40377.220
Home Square Footage	1828.034	632.129	1672.423***	548.087
Home Year Built	1973.234	16.881	1968.815***	19.375
Block Group% College	0.380	0.157	0.375***	0.156
Block Group% Liberal	0.408	0.086	0.454***	0.101
Donates to Environmental Causes	0.087	0.282	0.114***	0.318
Electric Heat Home	0.247	0.431	0.237***	0.425
Pays for Renewable Energy	0.070	0.256	0.141***	0.348
Treatment Group				
Receives Quarterly Report	0.222	0.412	0.304***	0.457
Receives Quarterly Report and in Like-minded community	0.138	0.341	0.395***	0.487
Observations Full Sample	21,193		21,172	

Note: A conservative is defined as Republican, American Party, or Libertarian. A liberal is defined as Democrat, Green, or Peace and Freedom. A "like-minded" community is defined for a conservative as a census block in the bottom quartile of fraction liberal. For a liberal, a "like-minded" community is defined as a census block in the top quartile of fraction liberal. The symbols ** and *** indicate that the differences between conservatives and liberals are statistically, significantly different at the 5 and 1 percent level (adjusting for block batch group), respectively.

Households living in electric homes were more likely to receive a monthly rather than a quarterly report.[12]

Table 2 shows that registered conservatives are slightly younger, have higher household incomes, larger households, and larger homes than registered liberals. While both conservatives and liberals donate to environmental causes and pay for renewable energy, liberals are more likely to do so. We could explain only 2%–4% of the variance in registered conservative status with age, household income, house value, house size, electric heat, and renter status (see Online Appendix Table A.1 for details).

Among the treated, liberals are more likely to receive the quarterly report, indicating that they use less electricity than conservatives. Liberals living in a liberal community (defined as a community in which the liberal share is in the top quartile) are almost three times as likely to receive the quarterly report as conservatives living in a conservative community (defined as a community in which the liberal share is in the bottom quartile). If political ideology does not affect the response to the HER, conservatives should respond more because they are treated more intensely.

12. Within a treated "block batch" households received either a monthly or quarterly report. Roughly 71% of households received the monthly report. Households with a low baseline electricity consumption received the quarterly report while households with a high baseline electricity consumption received the monthly report. Conditional that a household's daily average electricity consumption was less than 20 kWh per day it had a 2.5% chance of receiving the monthly report. Households whose 2006 electricity consumption was greater than 23 kWh per day had a 99% chance of receiving the monthly report.

5. Econometric Framework

Previous studies have examined the HER report's average treatment effect and have also examined how its effect varies by standard characteristics such as attributes of the home and socio-economic characteristics of the owner. The distinguishing feature of this study is our emphasis on household environmental ideology as an important determinant for how households respond to well-meaning new information.

We estimate intent-to-treat effects (which we will simply refer to as treatment effects) of receiving the HER by seven specifications of the form

$$\begin{aligned}\ln(kWh) = {} & \beta_0 + \beta_1(\textit{Household FE}) + \beta_2(\textit{Month/Year FE}) + \beta_3(\textit{Temp}, \textit{Electric}) \\ & + \beta_4 \textit{TREAT} + \beta_6(\textit{TREAT} \times \textit{Party Registration}) + \beta_7(\textit{TREAT} \\ & \times \textit{Green Indicators}) + \beta_8(\textit{TREAT} \times \textit{Individual Characteristics}) \\ & + \beta_9(\textit{TREAT} \times \textit{Block Characteristics}) \\ & + \beta_{10}(\textit{TREAT} \times \textit{House Characteristics}) \\ & + \beta_{11}(\textit{Post TreatmentPeriod Dummy} \times \textit{All Characteristics}) + \varepsilon, \qquad (1)\end{aligned}$$

where the unit of analysis is the household in a year and month and where TREAT is a dummy equal to one if the household received the Home Energy Report and where the different specifications use different subsets of the variables. TREAT thus is equal to 0 either if the household is never treated or is not yet treated. In all regressions we control for household and month/year fixed effects, a cubic in mean daily temperature within the billing cycle, and an interaction of the cubic mean daily temperature with a dummy indicator if the house is an electric house (Temp, Electric). We also interact party registration, green indicators, individual characteristics, block characteristics, and house characteristics with an indicator for whether the treatment period has started. Our political party indicators are liberal (Democrat, Green, or Peace and Freedom), other party (Reform, Conservative, Natural Law or Other), no party affiliation, and not registered, with conservative (Republican, American Party, and Libertarian) as the omitted dummy variable. Our green indicators are whether the household purchases energy from renewable sources and whether the household donates money to environmental causes. We cluster the standard errors on the block batch group to account for correlation within the block batch group. Our specifications differ in the number of included treatment interaction effects.

We examine who accepts treatment by estimating, for the treatment group, a probit regression of the form

$$\begin{aligned}\textit{OptOut} = {} & \beta_0 + \beta_1 \textit{High} + \beta_2 \ln(\textit{Usage}) + \beta_3 \textit{Age} + \beta_4 \textit{Liberal} \\ & + \beta_5 \textit{Unregistered} + \varepsilon, \qquad (2)\end{aligned}$$

where OptOut is a dummy variable equal to one if the household opts out of receiving the treatment, High is a dummy variable equal to one if the household's consumption

is above the neighborhood average, Usage is the household's electricity usage in 2006, Age is the age of the head of the household, Liberal is a dummy equal to one if the household head was registered as either a Democrat, Green, or Peace and Freedom party member, and Unregistered is a dummy equal to one of if the household was not registered.

Using a small surveyed sample, we also examine who, in the treatment group, found the reports of no value or disliked the reports by estimating probit regressions of the form

$$\begin{aligned} \textit{Report Reaction} = \beta_0 + \beta_1 \textit{High} + \beta_2 \ln(\textit{Usage}) + \beta_3 \textit{Age} + \beta_4 \textit{Liberal} \\ + \beta_5 \textit{Unregistered} + \varepsilon, \end{aligned} \tag{3}$$

where Report Reaction is either a dummy variable equal to one if the household found the reports of no value (responses of not at all or not very valuable) or a dummy variable equal to one if the household disliked the reports (responses of did not like or indifferent).

6. Results

Own ideology, whether measured by political party affiliation, donations to environmental organizations, or the purchase of green energy, is associated with differential treatment effects (see regression 2 in Table 3).[13] Although the mean overall treatment effect is –0.021 (see regression 1 in Table 3) when we do not allow for heterogeneous treatment effects, a registered conservative will decrease mean daily kWh by 1.7% in response to the treatment but a registered liberal will reduce consumption by 2.4%, all else equal (see regression 2 in Table 3). Those purchasing energy from renewable resources reduce their consumption by 0.9% in response to the treatment relative to those not purchasing green energy. Those donating to environmental organizations reduce their consumption by 1.1% more than households who do not donate to environmental organizations.

The fraction of liberals and the fraction of college-educated in the census block group affects treatment response, independent of own characteristics (see regression 3 in Table 3). An increase of 0.1 in the fraction of liberals in the census block group reduces consumption by 0.6% in response to the treatment. Controlling for the fraction of liberals in the block group leads to statistically insignificant effects of own party affiliation but leaves the effects of ideology as measured by donations unchanged. Own ideology, donating to environmental groups, and paying for renewable energy remain jointly statistically significant. The higher the fraction of college graduates in a census block group, the lower consumption.

13. We also have information on household monthly expenditure on electricity. In the presence of an increasing block tariff structure, some recipients of the HER may reduce their expenditure by more than their electricity consumption. We have estimated regressions similar to equation (1) in which we use the log of household monthly electricity expenditure as the dependent variable. We obtained very similar results.

TABLE 3. Treatment effects by ideology, education, and home structure.

	Dependent Variable: Log (Mean Daily kWh)					
	(1)	(2)	(3)	(4)	(5)	(6)
Treated	−0.021***	−0.017***	0.026**	0.069	0.016	0.008
	(0.003)	(0.003)	(0.011)	(0.063)	(0.073)	(0.008)
(Registered liberal)		−0.007**	−0.004	−0.004	−0.004	−0.005
		(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
(Registered other party)		0.031	0.028	0.028	0.030	0.028
		(0.032)	(0.032)	(0.032)	(0.031)	(0.032)
(No registered party)		0.004	0.004	0.004	0.003	0.004
		(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
(Not in voter registration data)		−0.003	−0.002	−0.002	−0.003	−0.002
		(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
(Donates to environmental organizations)		−0.011**	−0.011**	−0.010**	−0.009**	−0.011**
		(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
(Pays for renewable energy)		−0.009*	−0.006	−0.006	−0.006	−0.007
		(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
(Liberal share within block group)			−0.062***	−0.038*	−0.036*	
			(0.023)	(0.021)	(0.022)	
(College graduate share within block group)			−0.045***	−0.043**	−0.047**	−0.046***
			(0.017)	(0.018)	(0.019)	(0.018)
(Logarithm of age of house)				−0.009**	−0.007	
				(0.004)	(0.005)	
(Logarithm of square footage of house)				−0.003	−0.008	
				(0.007)	(0.007)	
(Electric House)				−0.014***	−0.014***	
				(0.005)	(0.005)	
(Logarithm of household income)					−0.001	
					(0.004)	
(Logarithm of home value)					0.008***	
					(0.003)	
(Dummy = 1 if renter)					−0.008	
					(0.018)	
(Second quintile of liberal share in block group)						−0.011
						(0.007)
(Third quintile of liberal share in block group)						−0.018***
						(0.007)
(Fourth quintile of liberal share in block group)						−0.010*
						(0.005)
(Fifth quintile of liberal share in block group)						−0.018*
						(0.010)
Joint significance of registered liberal, donates to environmental organizations, and pays for renewable energy, F(3,956)		5.68***	3.81***	3.30**	3.23**	3.98***
Household fixed effects	Y	Y	Y	Y	Y	Y
Month-Year fixed effects	Y	Y	Y	Y	Y	Y

TABLE 3. Continued

	Dependent Variable: Log (Mean Daily kWh)					
	(1)	(2)	(3)	(4)	(5)	(6)
Observations	2,760,175	2,760,175	2,760,175	2,760,141	2,754,232	2,760,175
R-squared	0.804	0.804	0.804	0.805	0.805	0.804

Note: Each observation is a household-billing cycle. Standard errors, clustered on the block batch group, are in parentheses. * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level. Additional control variables are a cubic in mean daily (24 hr.) temperature, the cubic in daily temperature interacted with a dummy indicating whether the home is an electric home, household fixed effects, year-month fixed effects, and interactions between characteristics and a time dummy indicating the experiment has started. Mean daily kWh are 31.69. Conservative is the omitted category and is defined as Republican, American Party, or Libertarian. Liberal is defined as Democrat, Green Party, or Peace and Freedom.

The fourth regression in Table 3 controls for the effect of house characteristics on treatment response. Those in older houses, in bigger homes, and in electric homes reduce their consumption more. Housing characteristics may reflect occupant characteristics. Liberals are more likely to be in older houses (but less likely to be in bigger homes). Controlling for housing characteristics, each increase of 0.1 in the fraction of liberals in the census block group reduces consumption by 0.4% in response to the treatment.

The fifth regression in Table 3 adds controls for the effect of household income, home value, and renter status on treatment response. There is no statistically significant differential treatment effect of renter status. The treatment effect is increasing in home value. The addition of these and the previous control variables reduces the impact of liberal share within the block group but does not affect how liberals respond to the treatment.

The sixth regression in Table 4 examines the linearity assumption on liberal share within census block group by substituting quintiles of the liberal share for liberal share within blocks. It shows that a greater liberal share relative to the lowest quintile is associated with households' reducing their electricity consumption in response to the treatment. The quintiles are jointly significantly different from 0 at the 10% level ($F(4,956) = 2.29$). We observe a similar pattern when we examined quartiles instead of quintiles (see regression 1 in Online Appendix Table A.2).

Our seventh and final regression (predicted values are graphed in Figure 1 and the regression is given in the last column of Online Appendix Table A.2) tests for persistence over time by adding indicators for whether the time period is during the first or second half of the experiment. It shows that registered conservatives who do not purchase renewable energy and who do not donate to environmental organizations reduce their consumption in response to the treatment by 0.01 in the first half of the experiment and by 0.02 in the second half of the experiment. Registered liberals who purchase renewable energy and who donate to environmental organizations reduce their consumption in response to the treatment by 0.04 in the first half of the experiment and by 0.05 in the second half of the experiment.

TABLE 4. Predicted Treatment Effects by Ideology

	Treatment Effect	Std. Err.
Using Regression 4 (Table 3)		
Registered liberal, pays for renewable energy, donates to environmental groups, and in top 75th percentile liberal block group	−0.036***	0.006
Registered liberals and in top 75th percentile liberal block group	−0.021***	0.003
Registered conservative, does not pay for renewable energy, does not donate to environmental groups, and in bottom 25th percentile liberal block group	−0.011***	0.003
Using Regression 6 (Table 3)		
Registered liberal, pays for renewable energy, donates to environmental groups, and in top 75th percentile liberal block group	−0.048***	0.010
Registered liberals and in top quintile liberal block group	−0.031***	0.009
Registered conservative, does not pay for renewable energy, does not donate to environmental groups, and in bottom quintile liberal block group	−0.008***	0.003

Note: Predicted treatment effects are estimated from Regressions 4 and 6 in Table 3. *** indicates statistical significance at the 1% level. Everyone in the treatment group is assigned the given characteristics while all other characteristics are kept at their median values. Conservative is defined as Republican, American Party, or Libertarian. Liberal is defined as Democrats, Green Party, and Peace and Freedom.

When we restricted the sample to households whose electricity usage was above the median in 2006 (precisely those households a utility would want to target to reduce total electricity demand), we obtained a similar response for liberals but a larger response for households who pay for renewable energy (see Online Appendix Table A.3). The effects of being in an electric home are no longer as large. When we examined households with baseline electricity usage below the median we found a smaller treatment effect and a statistically insignificant effect of paying for renewable energy and for donating to environmental groups (see Online Appendix Table A.4).

Table 4 examines the role that ideology plays in responding to receiving the HER. We use the regression results from Table 3's columns (4) and (6). Evaluating all characteristics at the median and using the regression in column (4), the treatment effect for liberals who purchase energy from renewable resources, who donate to environmental causes, and who live in a block group where the share of liberals is at least in the 75th percentile (less than 1% of our sample) is –0.036. The treatment effect for registered liberal who live in a block group where the share of liberals is at least in the 75th percentile (26% of our sample) is –0.021. The treatment effect for a conservative who does not pay for renewable energy, does not donate to environmental groups, and is in bottom 25th percentile liberal block group (22% of our sample) is –0.011. When we use the regression results from Table 3's column (6) we obtain a treatment effect of –0.008 for a conservative who does not pay for renewable energy, does not donate to environmental groups, and is in the bottom quintile liberal block group. The treatment effect for a liberal who pays for renewable energy, donates to environmental groups, and is in the top quintile liberal block group is –0.048.

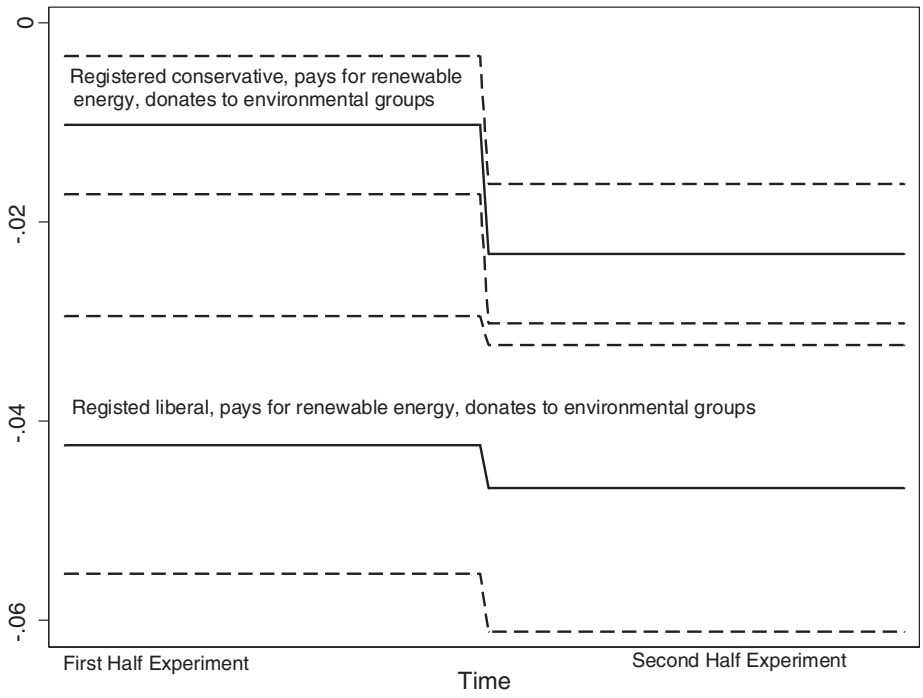


FIGURE 1. Predicted treatment effects over time. Predicted treatment effects are estimated from Regression 4 in Web Appendix Table 2. Upper and lower bounds of a 95% confidence interval are given as dashed lines. Everyone in the treatment group is assigned the given characteristics while all other characteristics are kept at their median values. Conservative is defined as Republican, American Party, or Libertarian. Liberal is defined as Democrats, Green Party, and Peace and Freedom. "First Half Experiment" refers to all observations in 2008 and thus includes roughly 8 months of treatment. "Second Half Experiment" refers to households in 2009 and thus includes about 10 months of treatment.

We further probed the robustness of our results by estimating equation (1) using quantile regressions (see Table 5). Estimating the impact of the HERs at the 10th, 25th, 50th, 75th, and 90th quantiles, our predicted results show that at the lower quantiles liberals who pay for renewable energy and donate to environmental organizations are three to four times as likely to reduce their consumption in response to the treatment as conservatives who do not pay for renewable energy and do not donate to environmental organizations. At the 90th quantile, differences between conservatives and liberals are smaller.

6.1. Persistence of the Report Effects

Our examination of seasonal patterns of response to the treatment leads us to conclude that liberals are more likely to turn down the air-conditioning in the summer in response to the treatment. When we added to equation (4) in Table 3 an interaction

TABLE 5. Treatment effects by ideology, quantile regressions.

	Dependent Variable: Log (Mean Daily kWh) Quantiles				
	0.10	0.25	0.50	0.75	0.90
Treated	−0.018***	−0.017***	−0.017	−0.017	−0.020***
	(0.002)	(0.002)	(0.021)	(0.031)	(0.006)
Treated x					
(Registered liberal)	−0.007***	−0.007***	−0.007	−0.006	−0.005**
	(0.003)	(0.002)	(0.039)	(0.043)	(0.003)
(Registered other party)	−0.009	0.013	0.014	0.027	0.073**
	(0.034)	(0.024)	(0.101)	(0.048)	(0.035)
(No registered party)	0.003	0.000	0.001	−0.001	0.005
	(0.005)	(0.003)	(0.061)	(0.055)	(0.009)
(Not in voter registration data)	−0.003	0.000	0.002	0.004	0.007
	(0.004)	(0.002)	(0.011)	(0.034)	(0.008)
(Donates to environmental organizations)	−0.019***	−0.014***	−0.009	−0.006	−0.000
	(0.006)	(0.003)	(0.074)	(0.104)	(0.008)
(Pays for renewable energy)	−0.002	−0.010***	−0.01	−0.009	−0.007
	(0.003)	(0.003)	(0.066)	(0.033)	(0.006)
Household fixed effects	Y	Y	Y	Y	Y
Month-Year fixed effects	Y	Y	Y	Y	Y
Observations	2,760,175	2,760,175	2,760,175	2,760,175	2,760,175
Pseudo *R*-squared	0.112	0.175	0.245	0.284	0.267
Predicted Treatment Effect					
Conservatives who do not donate to environmental organization or pay for renewable energy	−0.018	−0.017	−0.017	−0.017	−0.020
Liberals who donate to environmental organizations and pay for renewable energy	−0.046	−0.048	−0.043	−0.038	−0.032

Note: Each observation is a household-billing cycle. Bootstrap standard errors, clustered on the block batch group, are in parentheses. * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level. Additional control variables are a cubic in mean daily (24 hr.) temperature, the cubic in daily temperature interacted with a dummy indicating whether the home is an electric home, household fixed effects, year-month fixed effects, and interactions between characteristics and a time dummy indicating the experiment has started . Mean daily kWh are 31.69. Conservative is the omitted category and is defined as Republican, American Party, or Libertarian. Liberal is defined as Democrat, Green Party, or Peace and Freedom.

between treatment and summer months (May 1–October 31) and an interaction between treatment, summer months, and liberal, we obtained a coefficient on the interaction between treatment and summer months of –0.002 ($\sigma = 0.006$) and a coefficient on the interaction between treatment and summer months and liberal of –0.012 ($\widehat{\sigma} = 0.004$) (see Online Appendix Table A.2, column 3).

It is theoretically ambiguous whether the HERs will have a larger impact in the short run or the medium term. When a household first receives such a report this may be a salient event whose "new news" shocks the household and subsequent reports

reinforce the original news. In this case, we might observe a large drop in consumption followed by a constant level (climate adjusted).

Alternatively, in the medium term a household is more likely to adjust more of its durables stock and may make more energy efficient investments when it makes new investments in such durables. The evidence suggests that this strategy is being pursued. We found that households in the treatment group were more likely to obtain a rebate from the utility for purchasing an energy efficient durable. In a probit regression (see Online Appendix Table A.5) of the probability of obtaining a rebate on whether the household was in the treatment group, the household's political affiliation, the age of the household head, and the household's baseline electricity usage, we found that the derivative of the coefficient on the treatment dummy was a statistically significant 0.006 ($\sigma = 0.002$). At the sample mean of 0.056, this represents an 11% increase in the probability of obtaining a rebate.

6.2. Opting out of the Treatment

The decision to quit the HER treatment and consumer survey reactions to the HER provide additional evidence on which subgroups of the population disliked the treatment that are consistent with our identity story. Households could opt out of receiving the HER either by emailing, phoning, or mailing the utility. Although the information is free, 2% of households took action not to receive it and 36% of the survey group reported disliking the report. Our results have implications not just for our identity hypothesis but also for the long-term success of the HER program among different types of households.

Households that opted out of the treatment were more likely to be high electricity consumers, both relative to their neighbors and in absolute levels, and they were less likely to be liberals than conservatives (see Table 6). At the mean opt out rate of 0.020, a liberal was 15% less likely to opt out. High electricity users relative to their neighbors were 65% more likely to opt out.

In a subsample of 1,061 consumers interviewed about the home energy reports, high electricity users, both relative to their neighbors and in absolute levels, were more likely to claim that the reports were useless or that they disliked them. Liberals were less likely than conservatives to state that the reports were useless or that they disliked them. Being liberal decreased the probability of finding a report useless by 0.131, a decrease of 44% from the sample mean of 0.301. Being a liberal decreased the probability of disliking the report by 0.102, a decrease of 28% from the sample mean of 0.363. High electricity users relative to their neighbors were 27% more likely to find the report useless and were 38% more likely to report disliking the report.

Liberals and conservatives did not report differential rates of spending less than 2 minutes reading the report (see the last column in Online Appendix Table A.5). High users were statistically, significantly more likely to spend less time reading the report.

TABLE 6. Decision to opt out of treatment and view of reports by ideology.

	Dependent Variable = 1 if Reports of Dislike		
	Opt Out	No Value	Reports
Dummy = 1 if			
Above community mean electricity use	0.013***	0.082**	0.138***
	(0.002)	(0.035)	(0.036)
Logarithm of 2006 electricity consumption	0.008***	0.159***	0.103***
	(0.002)	(0.038)	(0.040)
Age of household head	0.000***	0.003***	0.001
	(0.000)	(0.001)	(0.001)
Dummy = 1 if registered			
Republican, American Party, Libertarian			
Democrat, Green, Peace and Freedom	−0.003**	−0.131***	−0.102***
	(0.001)	(0.032)	(0.035)
Dummy = 1 if not registered	−0.004**	−0.078**	−0.031
	(0.001)	(0.032)	(0.036)
Pseudo *R*-squared	0.062	0.055	0.04
Observations	32,667	1,061	1,061

Note: The opt out decision is estimated for all treated households. Registered voters with no party affiliation or with an affiliation other than Republican, American Party, Libertarian, Democrat, Green, Peace, and Freedom are not included in the regressions. The mean opt out rate is 0.020. A subsample of the treatment group was interviewed about the home energy reports. 30.1% of the sample found the reports to be not at all or not very valuable. 36.3% of the sample reported not liking or being indifferent about receiving the reports. Standard errors are in parentheses.

6.3 A Regression Discontinuity Test of Differential Responses to Normative Messages

This paper's main focus has been to estimate the differential response of environmentalists and non-environmentalists to receiving a HER report. We have also examined whether, among those who received a HER report, there is a differential response between political liberals and conservatives to the normative message included with the first report.

Households received one of three normative messages: "great", "good", or "room for improvement". These normative messages were based on the household's consumption compared to that of 100 neighbors living in similar-sized houses. For the first report only we observe both the normative message and the ratio of the household's electricity consumption in the last month divided by the average consumption of 100 nearby neighbors.

As discussed in the Online Appendix, we implemented a regression discontinuity design (see Lee and Lemieux 2010) to test whether political ideology influences how households respond to receiving sharp normative feedback. Although our point estimates suggest that a political conservative increases consumption by 5.7% in response to receiving a normative message of "good" versus "room for improvement" whereas a political liberal increases consumption by only 0.9%, the 95% point wise confidence intervals are large and we fail to reject the hypothesis that there is no "normative message" for either conservatives or liberals.

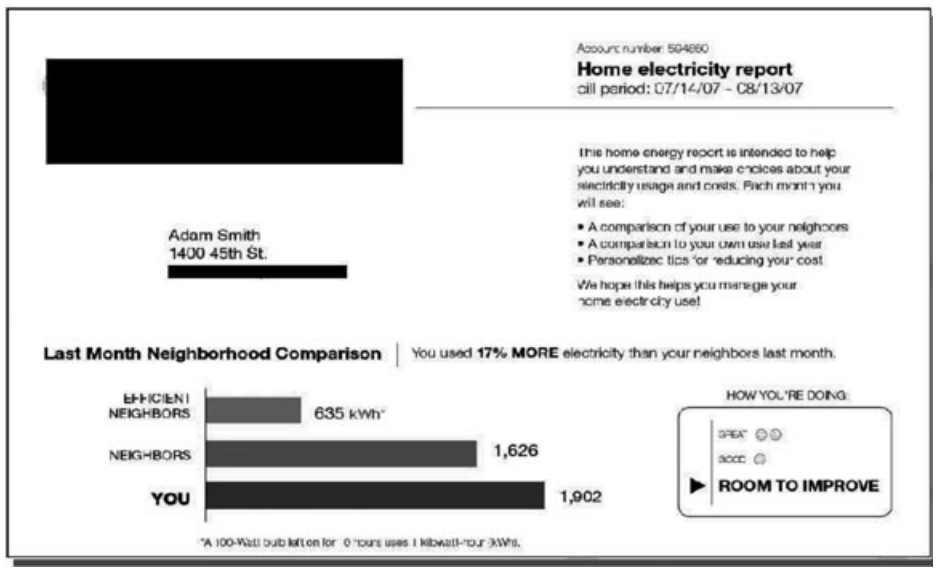
7. Conclusion

"Nudges" can make us healthier, richer in our retirement (through opt out defaults), and better environmental citizens. Given that such information treatments are cheap to produce and distribute, these could be cost-effective policies especially for those subsets of households who are most responsive to these treatments.[14]

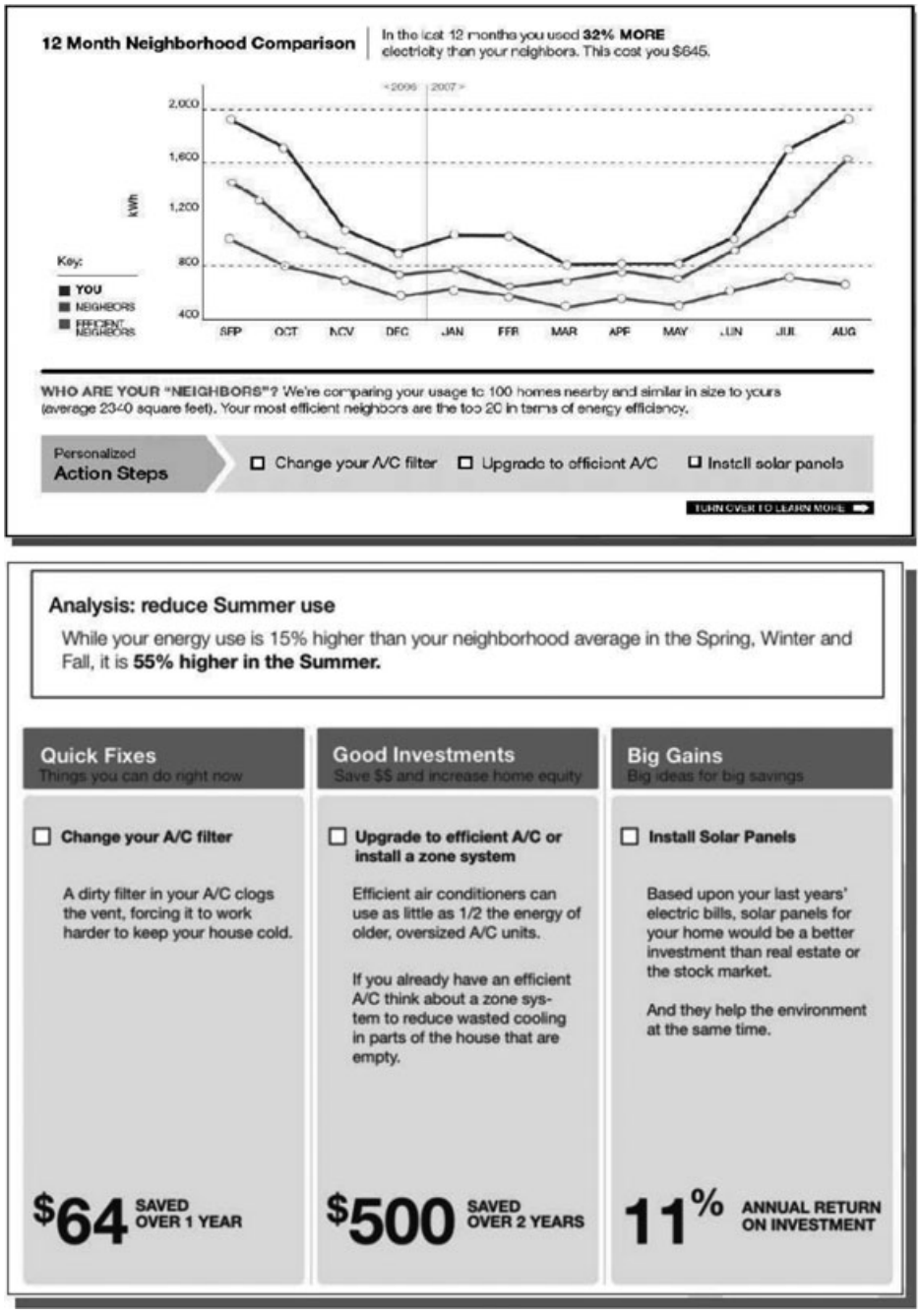
This paper exploited a unique data merge of information from an electricity information provision field experiment to study how liberal/environmental ideology mediates responses to peer comparison information. Liberal households are less likely to drop out of the experiment and more likely to report that they like receiving the report than political conservatives. In response to receiving the report, liberals reduce their electricity consumption by a larger percentage than conservatives.

Our results suggest that environmental nudges are most effective in relatively liberal communities. What works in California may not work in Lubbock, Texas. And even in California, targeted messaging may be more cost-effective than random assignment of home energy reports. Future research should continue to test for what might be effective conservation messages with political conservatives.

Appendix. Sample Home Electricity Report



14. Allcott (2011) provides an excellent cost–benefit analysis of electricity nudges.



Source: Residential Energy Use Behavior Change Pilot, OPOWER white paper, http://www.opower.com/LinkClick.aspx?fileticket=cLLj7p8LwGU%3d&tabid=7

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's website:

Table A.1. Correlates of being a registered conservative and of being a registered conservative who does not donate to environmental groups, does not pay for renewable energy, and lives in a conservative area.
Table A.2. Treatment effects by ideology.
Table A.3. Treatment effects by ideology, education, and structure for households above the median baseline usage.
Table A.4. Treatment effects by ideology, education, and structure for households below the median baseline usage.

Table A.5. Correlates of probability of obtaining a rebate to purchase an energy efficient durable and of spending less than 2 minutes reading the home energy report.
Table A.6. Regression discontinuity test of differential responses to a normative message.
Figure A.1. Density of household/neighbor kWh, conservatives. Density of the ratio of average daily household kWh to average daily kWh of 100 nearest neighbors living in a similar sized house in the first HER report received. Conservative is defined as Republican, American Party, or Libertarian.
Figure A.2. Density of household/neighbor kWh, liberals. Density of the ratio of average daily household kWh to average daily kWh of 100 nearest neighbors living in a similar sized house in the first HER report received. Liberal is defined as Democrat, Green Party, or Peace and Freedom.
Figure A.3. Change in electricity consumption for conservatives who receive a her and are at the "Good" versus "Room for Improvement" Cutoff.
Figure A.4. Change in electricity consumption for liberals who receive a her and are at the "Good" versus "Room for Improvement" Cutoff.