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ABSTRACT

"Nudges" are being widely promoted to encourage energy conservation. We show that while the electricity conservation "nudge" of providing feedback to households on own and peers' home electricity usage works with liberals, it can backfire with conservatives. Our regression estimates predict that a Democratic household that pays for electricity from renewable sources, that donates to environmental groups, and that lives in a liberal neighborhood reduces its consumption by 3 percent in response to this nudge. A Republican household that does not pay for electricity from renewable sources and that does not donate to environmental groups increases its consumption by 1 percent.

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Residential electricity consumption represents roughly 35% of California's total electricity demand. Conservation by consumers would both reduce greenhouse gas emissions and economize on the construction of costly new power plants. But how can conservation be encouraged?

Behavioral economists have promoted the use of "nudges" to encourage energy conservation (Allcott and Mullainathan 2010; Thaler and Sunstein 2008). "Nudges" offer a politically palatable alternative to stricter building codes and price increases. Allcott (2009) , 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 percent, potentially saving 110 million kWh per year if feedback were provided to all of the utility's customers (Ayers et al. 2009). When California initiated a media campaign in 2001 to promote voluntary conservation, consumption in San Diego declined by 7% during the initial two phases of the campaign, before rebounding. The declines were as large as those achieved through an unexpected doubling of the electricity prices, without the resulting political outcry that led to a cap on prices (Reiss and White 2008).

We argue that behavioral economists have underestimated the role that ideological heterogeneity plays in determining the effectiveness of energy conservation "nudges." We find that the effectiveness of energy conservation "nudges" depend on an individual's political views. Although liberals and environmentalists are more energy efficient than conservatives (Costa and Kahn 2010), thus making it harder for them to reduce consumption further, we find that liberals and environmentalists are more responsive to these nudges than the average person. In contrast, for certain subsets of Republican registered voters, we find that the specific "treatment nudge" that we evaluate has the unintended consequence of increasing electricity consumption.

The treatment effects literature has emphasized the theoretical existence of "defiers" – individuals who refuse the treatment and do the opposite of what they are told (Freedman 2006), but has provided few specific examples of what motivates the "defiers." We argue that political ideology provides one motivation for defiance. Some may feel active anger at receiving the "nudge." When radio talk show host Rush Limbaugh encouraged his listeners to turn on all lights for Earth Hour, he argued that reducing electrical consumption would lower the state's tax revenues and thereby lead to higher taxes.[1] There are other potential reasons for increasing consumption or for not responding to a "nudge." An energy conservation "nudge" may be ignored by conservative Republicans. Some may increase their consumption as they learn that their past consumption was "low." Such a boomerang effect could be caused by the realization that electricity is cheaper than they expected and that it is "normal" to consume more.

Rising polarization between Democrats and Republicans has been well documented and environmental issues are a leading case.[2] 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 4 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

[1] Appealing to his listeners' anti-Big Brother sentiments, he stated, "There are people who want to tell you how you should live via and by way of their government officials. There are more people that are going to support this, "Save the planet," all this sort of garbage. "Conserve energy! Go green!" all this stuff, I mean this is the culmination here of decades of propaganda how prosperity is destroyed in the planet." See Turn on Your Lights Before the State Smart Meter Turns Them Off March 26, 2009, http://www.rushlimbaugh.com/home/daily/site_032609/content/01125111.guest.html

[2] See Keith Poole's web site, www.voteview.com .

Republican leadership a score of 3.[3] 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. Prescriptions for energy policy differ between Democrats and Republicans: 88 percent of Republicans favor drilling in U.S. waters compared to 56 percent of Democrats.[4] The two word phrase "fuel efficiency" was one of the top phrases used by Congressional Democrats but not by Republicans (Gentzkow and Shapiro 2010).

Our evidence on the role of ideology in energy conservation "nudges" comes from a randomized field experiment carried out by a large California utility district. Starting in Spring 2008, it 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 individual 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. This observable variation is crucial in distinguishing our estimation strategy from previous studies that have focused on estimating average treatment effects.

[3] See http://www.lcv.org/2008-pdf.pdf .
[4] See Independents Take Center Stage in Obama Era: Trends in Political Values and Core Attitudes: 1987-2009, May 21, 2009, http://people-press.org/report/517/political-values-and-core-attitudes .

Our emphasis on political ideology (often an unobservable in standard economic studies) allows us to document that the recovered average treatment effect is a mixture of negative and positive treatment responses by different ideological subgroups of the population. Political ideology provides a plausible micro-foundation for essential heterogeneity (Heckman, Urzua, and Vytlacil 2006). If the *same* message "turns on" greens but "turns off" more conservative individuals, then to reach out to all members of a diverse population requires a mixed-messages strategy.

Economic Framework

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 ideology as a set of exogenous prior beliefs, including those about the importance of energy conservation. The ideological divide on environmental issues between Democrats and Republicans will affect how a household responds to an energy conservation "nudge."

The "nudge" that the electric utility company sends to treatment households in an on-going randomized experiment to encourage reductions in electricity consumption is a two page

Home Electricity Report (see Appendix A for a sample). 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 (not shown in Appendix A). 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.

We view the receipt of a Home Electricity Report as intent to treat. A household could refuse treatment either by opting out of receiving future reports (a relatively costly action because it requires either a phone, email, or written mailed request) or by ignoring the report. If it takes the report seriously, it accepts the treatment. In this evaluation framework, ideology determines both whether a household decides to take the treatment and, if it takes the treatment, its response to the treatment (i.e. turning up the thermostat in summer or buying more energy efficient durables). Ideology is thus a dimension of essential heterogeneity (Heckman et al 2006).

Environmentalist households may read the report because they want to lower their consumption. Conservative households may read the report if they are suspicious of all green initiatives. Once a household decides to accept the treatment, it responds to the treatment with varying levels of intensity. An environmentalist household interested ex-ante in lowering its consumption may decrease its electricity consumption unless the report contains no "new news". An avid environmentalist household may have engaged in the time intensive activity of tracking its own monthly electricity consumption and talking to neighbors about their consumption. In

this case, the HER may have no behavioral impact on this "green group." Conversely, a household that is adamantly anti-environmentalist may pride itself on increasing its consumption. Because 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), the receipt of a report that looks "green" may inspire defiance.[5]

Many households will read the report for non-ideological reasons, such as wanting to lower their bill. These households, regardless of ideology, may reduce their consumption. But perverse effects could happen here too. A household mainly concerned with the size of its electricity bill may increase its consumption if it learns that the savings from conservation are relatively modest (e.g. if it learns that by being "smart" about heated blankets and pads it can save at most $10 per year). A household that realizes it is below the neighborhood average in consumption may increase its consumption. This "boomerang effect" is discussed in Allcott (2009) and Ayers et. al. (2009).

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

[5] The psychology of defiance may be explained by psychological reactance (Brehm 1966) which postulates an emotional reaction occurring when rules or regulations threaten specific behavioral freedoms. Alternatively, it may be a personality feature. Agreeable compliance is dimension II in a five factor personality model (Digman 1990; Borghans, Duckworth, Heckman, and Weel 2008).

receiving the report, either on a quarterly or monthly basis. A control group of roughly 49,000 households have never received a Home Electricity Report.

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 5 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 (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 Home Electricity Reports in the same community would lead to greater energy savings.[6]

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

[6] 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 Home Energy Report did not inspire discussion and that any positive peer effects operate through implicit social pressure.

sources. We link each billing cycle to the mean daytime and nighttime temperature in that billing cycle.[7]

We link the billing data to the treatment and control data which contain information on when the household began to receive the Home Energy Reports, 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. The treatment and control data contain 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 to our data set.[8] For registered voters we know party affiliation, level of education, 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.[9] The individuals we could not link were living in smaller households and in block groups with a low proportion of the college-educated, were more likely to receive a subsidy for electricity because of their low income, and were more likely to have a household head above age 60.[10] We also merge to these data, by the block group, the share of registered voters who were liberal (Democrat, Green, or Peace and Freedom) in 2000 and the share of the

[7] Two different households in the same calendar year and same month who are on different billing cycles will face *different* climate conditions and electricity prices. Any two households on the same billing cycle will face the same average temperature but since different households are on different billing cycles within the same month, we have within month variation in climate.

[8] We purchased the data from www.aristotle.com.

[9] Only 5% of households were "mixed" between conservatives and liberals.

[10] 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.

college-educated in the block group. We expect that environmentalists are more likely to live in liberal, educated communities.

We have access to two other 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 and we know whether the household has signed up for the company's renewable power program. 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.[11]

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 1061 observations.

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

[11] The collected revenue is used by the electric utility to purchase and produce power from wind, water, and sun.

homeowner.[12] The geographical areas included in the experiment have a much higher share of college graduates than the average county home owner's community.

The randomization of the HER across blocks was effective. Ayers et al. (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. Households living in electric homes were more likely to receive a monthly rather than a quarterly report.[13]

Econometric Framework

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

1) $\ln(kWh) = \beta_0 + \beta_1(Household\ FE) + \beta_2(Month/Year\ FE) + \beta_3(Temp, Electric) + \beta_4 TREAT + \varepsilon$

2) $\ln(kWh) = \beta_0 + \beta_1(Household\ FE) + \beta_2(Month/Year\ FE) + \beta_3(Temp, Electric) + \beta_4 TREAT + \beta_6(TREAT \times Party\ Registration) + \beta_7(TREAT \times Green\ Indicators) + \varepsilon$

3) $\ln(kWh) = \beta_0 + \beta_1(Household\ FE) + \beta_2(Month/Year\ FE) + \beta_3(Temp, Electric) + \beta_4 TREAT + \beta_6(TREAT \times Party\ Registration) + \beta_7(TREAT \times Green\ Indicators) + \beta_{10}(TREAT \times College\ Graduate) + \beta_{11}(TREAT \times Block\ Characteristics) + \varepsilon$

[12] Household income is available from credit bureau data.

[13] For households assigned to the treatment group, the probability of receiving a monthly HER report increases as a function of household baseline electricity consumption. Roughly 71% of households received the monthly report but conditional that a household's daily average electricity consumption was less than 20 kWh it had a 2.5% chance of receiving the monthly report while the set of households whose 2006 electricity consumption was greater than 23 kWh had a 99% chance of receiving the monthly report.

4) $\ln(kWh) = \beta_0 + \beta_1(Household\ FE) + \beta_2(Month/Year\ FE) + \beta_3(Temp, Electric) +$

$\beta_4 TREAT + \beta_6(TREAT \times Party\ Registration) + \beta_7(TREAT \times Green\ Indicators) +$

$\beta_{10}(TREAT\ \times College\ Graduate) + \beta_{11}(TREAT\ \times Block\ Characteristics) +$

$\beta_{12}(TREAT\ \times House\ Characteristics) + \varepsilon$

where TREAT is a dummy equal to one if the household received the treatment effect, that is, if the household received the Home Energy Report.

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).[14] We cluster the standard errors on the household to account for autocorrelation in monthly electricity consumption (Bertrand, Duflo, and Mullainathan 2004). We assume that there are no contemporaneous shocks to each contiguous block batch group after controlling for month/year fixed effects, household fixed effects, and average billing cycle temperature.[15]

The first regression estimates a treatment effect with no heterogeneous responses. The second regression adds treatment effects by political party registration: liberal (Democrat, Green, or Peace and Freedom) no party affiliation, other party, and not registered, with conservative (Republican, American Party, and Libertarian) as the omitted dummy variable. The fourth regression allows for additional treatment effects by whether the household purchases energy from renewable sources and whether the household donates money to environmental causes (Green Indicators). The fifth regression additionally allows for differential treatment

[14] Although we allow the treatment effect to vary by education level, we do not interact the treatment effect with the household's income level because Allcott (2009) found that treatment effects do not vary by income.

[15] This assumption would break down if we had temperature shocks that were specific to a block batch group. We do not believe that there is significant climate zone variation within the electric utility's service area.

effects by whether the household is college-educated and by the block characteristics of the share of college educated and of liberals (Democrats, Greens, and Peace and Freedom) in the census block group. The sixth regression also allows for differential treatment effects by the type of house: the logarithm of square footage, the logarithm of the age of the house, and whether the house is an electric house.

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

$$OptOut = \beta_0 + \beta_1 High + \beta_2 \ln(Usage) + \beta_3 Age + \beta_4 Liberal + \beta_5 Unregistered + \varepsilon$$

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.

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

$$Report\ Reaction = \beta_0 + \beta_1 High + \beta_2 \ln(Usage) + \beta_3 Age + \beta_4 Liberal + \beta_5 Unregistered + \varepsilon$$

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).

As shown in equations (1 to 4), we are estimating a reduced form treatment effect. In the program evaluation literature, researchers routinely have access to a single instrumental variable

that affects the probability of taking a single treatment (such as enlisting in the army). Unlike in the standard LATE framework, in the case of household electricity consumption, there are multiple treatments that a household may take after being randomly assigned the HER (the instrument). Since there is only one instrument but there are multiple treatments (ranging from changing your durables stock to changing your utilization of your existing stock), we simply seek to estimate the total effect of these reports.

The evidence we report below represents a distinctive example of a randomized field experiment in which the LATE monotonicity assumption does not hold (Angrist and Imbens 1994; Imbens and Wooldridge 2009; Deaton 2009; Imbens 2009).[16] For researchers who ignore the role of ideology, we will show that the same treatment (the HER) raises the probability of taking "the treatment" for some people and lowers it for others. One can construct examples in which such non-monotonic responses yields a Wald Estimator with a zero in the denominator.[17]

[16] Other examples of the violations of the monotonicity assumption are found in Heckman, Lochner, and Taber (1999), Doyle (2008), and Barua and Lang (2009).

[17] Consider the simple univariate framework in which electricity consumption Y is determined by a binary action energy conservation action D and unobserved factors U.

$Y = a + b*D + U$

The population consists of two types. Fifty percent of the population are greens and their probability of taking the treatment = 0.6 + 0.2*1(HER) and 50% are "browns" and their probability of taking the treatment = 0 .2 - 0.2*1(HER). Note that greens respond to the HER report by increasing their likelihood of taking action D while browns respond in the opposite way. Consider the Wald Estimator in this case that uses the randomized HER report as an instrument for D. The estimator takes the form: $(E(Y|HER=1) – E(Y|HER=0))/(E(D|HER=1) – E(D|HER=0))$. Note that given the assumptions above that the denominator equals zero. If a researcher could partition households by ideological type and estimate the IV regression for greens and browns separately, this problem would not arise.

Results

Table 2 shows the mean overall treatment effect and the treatment effect by own and neighborhood ideology, own and neighborhood education, and house characteristics using specifications 1-4. We obtain a mean overall treatment effect of -0.021 (see regression 1).[18]

The second regression in Table 2 show that own ideology, whether measured by political party affiliation, donations to environmental organizations, or the purchase of green energy, leads to differential treatment effects. A registered conservative will decrease mean daily kWh by only 0.4 percent in response to the treatment but that a registered liberal will reduce consumption by 1.1 percent. Unregistered voters have a large response to the treatment effect: the treated reduce their consumption by 2.9 percent relative to registered conservatives. Those purchasing energy from renewable resources reduce their consumption by 1.5 percent relative to those not purchasing green energy. Those donating to environmental organizations reduce their consumption by 1.0 percent.[19]

The third regression shows that community characteristics affect the treatment response, independent of own characteristics. This specification adds own education, the fraction of liberals in the block group, and the fraction of college-educated in the block group. Even

[18] We also have information on household monthly expenditure on electricity. In the presence of an increasing block tariff structure, some recipients of the Home Energy Report may reduce their expenditure by more than their electricity consumption. This is possible for those whose consumption (before receiving the HER) just places them on an upper pricing tier. For this group, small reductions in electricity consumption can lead to larger reductions in electricity expenditure. We have estimated regressions similar to equation 4 in which we use the log of household monthly electricity expenditure as the dependent variable. We obtained very similar results on ideology and found positive treatment effects for one quarter of the sample.

[19] Previous research has shown that environmentalists exhibit "greener" day to day consumption choices than the average person; as measured by electricity consumption (Kotchen and Moore 2007), vehicle choice (Kahn 2007, Kahn and Vaughn 2009) and public transit use (Kahn and Morris 2009).

controlling for own ideology, an increase of 0.1 in the fraction of liberals (Democrats, Greens, or Peace and Freedom) reduces consumption by 1.0 percent. Controlling for neighborhood ideology reduces, by a small amount, the size of the coefficients on the interaction of treatment with own ideology. College graduates are no more likely than non-college graduates to change their consumption in response to the treatment but those living in a census block group with a higher fraction of college graduates are more likely to reduce their consumption.

The last regression 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). Unregistered voters are more likely to be in electric homes and in smaller homes. Controlling for housing characteristics, relative to conservatives, liberals reduce their consumption by 0.8 percent and each increase of 0.1 in the fraction of liberals in the census block group reduces consumption by 0.7 percent.

Treatment effects estimated from the sixth regression in Table 3 are positive for roughly a fifth of the sample (see Figure 1). These treated households who increase their consumption are on average increasing their daily usage by 0.34 kwH from a baseline usage of 30.79 kWh per day. Facing an increasing block tariff pricing scheme, at Tier 2 summer rates, they are paying an extra $2 per month for increasing their consumption. Treatment effects are positive for 41% of conservatives compared to 19% of liberals. Treatment effects are positive for only 6% of liberals who purchase energy from renewable resources and who donate to environmental causes.

When we restricted the sample to households whose electricity usage was above the median in 2006, we obtained a similar response for liberals but a larger response for households who pay for renewable energy (see Table 4). The effects of being in an older home and in an electric home are no longer as large and each doubling of household square footage increases the treatment effect by 1.8 percent.

Table 5 examines the role that environmental ideology plays in responding to receiving the HER. We use the regression results from Table 3's column (4) and Table 4's column (4). Evaluating all characteristics at the median, 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 is -0.031. 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 is 0.007. If this type of conservative (does not pay for renewable energy, does not donate to environmental groups, and is in the bottom 25th percentile liberal block group) consumed above the median in 2006, the treatment effect is not statistically distinguishable from 0. The treatment effect becomes -0.055 for a liberal who consumed above the median in 2006 and who purchases energy from renewable resources, who donates to environmental causes, and who lives in a block group where the share of liberals is at least in the 75th percentile.

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 6 in Table 3 an interaction 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

0.003 ($\hat{\sigma}$=0.002) and a coefficient on the interaction between treatment and summer months and liberal of -0.032 ($\hat{\sigma}$=0.002). When we examined households living in electric homes (results not shown), we found that these households mainly adjusted in the summer but they also adjusted in the cooler months (March, April, October, and November). They did not adjust in the coldest months (December, January, and February).

It is theoretically ambiguous whether the HER reports 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.[20] The evidence suggests that this strategy is not being pursued. We found evidence 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 (results not shown) 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 ($\hat{\sigma}$=0.002). At the sample mean of 0.056, this represents an 11 percent increase in the probability of obtaining a rebate.

[20] We also examined the persistence of the treatment effect. We found that in 2009 positive treatment effects among low using Republicans become smaller relative to 2008, but we found no differential effects for liberals.

Opting out of the Treatment

The costly decision to quit the HER treatment provides additional evidence on which subgroups of the population did not want to participate in this treatment. 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% percent less likely to opt out. In a subsample of consumers interviewed about the home energy reports, high electricity users 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. Liberals and conservatives did not report differential rates of spending less than 2 minutes reading the report (results not shown).

Conclusion

"Nudge" based policy prescriptions seek to make us healthier, richer in our retirement (through opt out defaults), and better environmental citizens. In one consumer finance experiment, "nudges" that are inexpensive to implement are as effective as large relative price changes (Bertrand et al. 2010).

We have shown that while energy conservation "nudges" work with liberals, they backfire with conservatives. Greens may reduce their consumption in response to the receipt of a Home Energy Report because both private and social effects work in the same direction. They want to be good global citizens and suffer when they are made aware that they are "part of

the problem." The knowledge that their absolute and relative levels of consumption are known to the electric utility may only reinforce the desire to reduce consumption. In contrast, non-greens not only may feel no desire to engage in voluntary restraint, but, aware that they are being watched, may increase their consumption to tweak the authority's nose. Individual, political commentary, and party positions on environmental issues have become more extreme over the last quarter of a century (Dunlap, Xiao, and McCright 2001) and this may re-enforce differential behavioral responses. List (2007) highlights in an experimental setting how households signal their types through the actions they take. These "defiers" pose a challenge for the design of public policies intended to mitigate social externalities. To design nudges effectively, a "nudger" must anticipate how diverse subjects will respond.

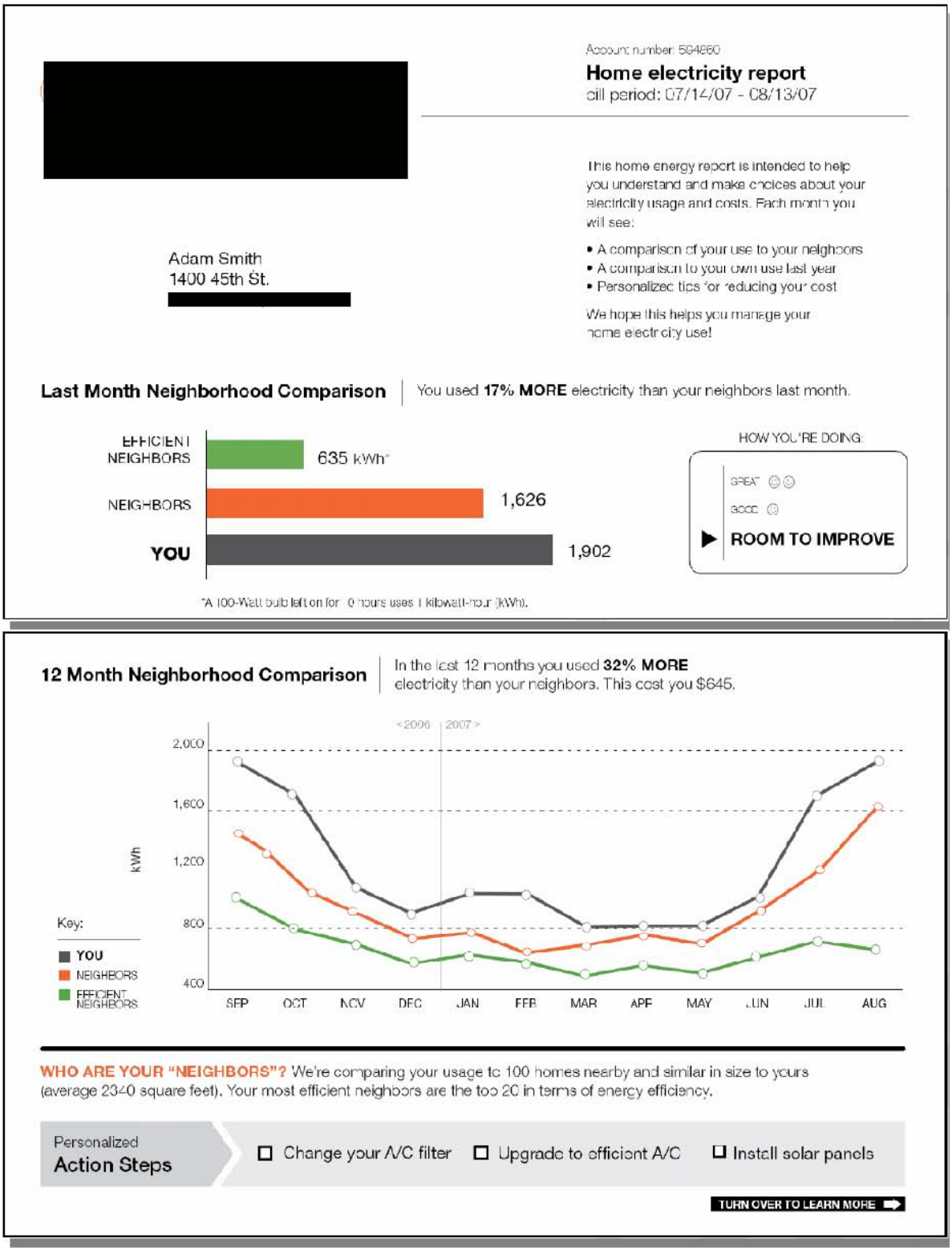
Deaton (2009) has emphasized that heterogeneous responses to a treatment are not merely a technical problem but a symptom of the failure to specify the causal model. The obvious lesson for field experiments is that on polarized issues even seemingly innocuous messages may trigger perverse effects. What works on average in this California county may not work on average in Lubbock, Texas if the proportion of greens is less in Lubbock. Messages need to be targeted to particular ideological groups, as learned by politicians who have strategically adopted extremism to induce their supporters to show up to the polls (Glaeser, Ponzetto, and Shapiro 2005).

Energy conservation "nudges" may need to be combined with more traditional, but perhaps more politically costly, policies such as strict building code prices and higher prices. Building codes have been effective in reducing electricity consumption by around 15 percent (Aroonruengsawat and Auffhammer 2009; Costa and Kahn 2010; Jacobson and Kotchen 2009)

and higher electricity prices both in the short term and through a long run impact on durables choice would reduce consumption.[21]

[21] Recent estimates of price elasticities are -0.39 (Reiss and White 2005) and -0.22 (Borenstein 2009).

Appendix A: Sample Home Electricity Report



Source: Residential Energy Use Behavior Change Pilot, OPOWER white paper, http://www.opower.com/LinkClick.aspx?fileticket=cLLj7p8LwGU%3d&tabid=76

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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)	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	66484.710	43252.980	74826.920	41364.310	74312.590	41546.760
Home Square Footage	1709.447	682.612	1720.876	602.086	1706.109	578.296
Home Year Built	1976.764	20.619	1971.176	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
College Educated	0.355	0.479	0.411	0.492	0.406	0.491
Donates to Environmental Causes	0.082	0.275	0.099	0.299	0.097	0.296
Electric 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.

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
College Educated	0.419	0.493	0.403	0.490
Donates to Environmental Causes	0.087	0.282	0.114	0.318
Electric Home	0.247	0.431	0.237	0.425
Pays for Renewable Energy	0.070	0.256	0.141	0.348
Observations	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.

Table 3: Treatment Effects by Ideology, Education, and Structure

	Dependent Variable: Log(Mean Daily kWh)			
	(1)	(2)	(3)	(4)
Treated	-0.021***	-0.004*	0.059***	0.213***
	(0.002)	(0.002)	(0.006)	(0.040)
Treated x				
(Registered conservative)				
(Registered liberal)		-0.011***	-0.007***	-0.008***
		(0.003)	(0.003)	(0.003)
(Registered other party)		0.023	0.019	0.019
		(0.026)	(0.025)	(0.026)
(No registered party)		0.002	0.003	0.003
		(0.004)	(0.004)	(0.004)
(Not in voter registration data)		-0.029***	-0.027***	-0.028***
		(0.003)	(0.003)	(0.003)
(Donates to environmental organizations)		-0.010***	-0.011***	-0.009**
		(0.004)	(0.004)	(0.004)
(Pays for renewable energy)		-0.015***	-0.011***	-0.010**
		(0.004)	(0.004)	(0.004)
(College graduate)			0.004	0.004
			(0.003)	(0.003)
(Liberal share within block group)			-0.096***	-0.071***
			(0.013)	(0.014)
(College graduate share within block group)			-0.067***	-0.058***
			(0.008)	(0.008)
(Logarithm of age of house)				-0.017***
				(0.003)
(Logarithm of square footage of house)				-0.014***
				(0.005)
(Electric House)				-0.028***
				(0.003)
Household fixed effects	Y	Y	Y	Y
Month-Year fixed effects	Y	Y	Y	Y
Observations	2,760,175	2,760,175	2,760,175	2,760,141
R-squared	0.804	0.804	0.804	0.804

Note: Each observation is a household-billing cycle. Standard errors 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, and year-month fixed effects. Mean daily kWh are 31.69. Conservative is defined as Republican, American Party, or Libertarian. Liberal is defined as Democrat, Green Party, or Peace and Freedom.

Table 4: Treatment Effects by Ideology, Education, and Structure among Heavy Users

	Dependent Variable: Log(Mean Daily kWh)			
	(1)	(2)	(3)	(4)
Treated	-0.025***	-0.005*	0.063***	-0.105*
	(0.002)	(0.003)	(0.009)	(0.054)
Treated x				
(Registered conservative)				
(Registered liberal)		-0.015***	-0.010***	-0.009***
		(0.003)	(0.003)	(0.003)
(Registered other party)		0.031	0.028	0.029
		(0.035)	(0.034)	(0.035)
(No registered party)		-0.004	-0.003	-0.002
		(0.005)	(0.005)	(0.005)
(Not in voter registration data)		-0.037***	-0.032***	-0.031***
		(0.004)	(0.004)	(0.004)
(Donates to environmental organizations)		-0.010*	-0.012**	-0.010**
		(0.005)	(0.005)	(0.005)
(Pays for renewable energy)		-0.023***	-0.020***	-0.019***
		(0.006)	(0.006)	(0.006)
(College graduate)			0.010***	0.008**
			(0.003)	(0.003)
(Liberal share within block group)			-0.122***	-0.077***
			(0.018)	(0.020)
(College graduate share within block group)			-0.062***	-0.086***
			(0.010)	(0.011)
(Logarithm of age of house)				-0.010***
				(0.003)
(Logarithm of square footage of house)				0.026***
				(0.007)
(Electric House)				-0.013***
				(0.003)
Household fixed effects	Y	Y	Y	Y
Month-Year fixed effects	Y	Y	Y	Y
Observations	1,379,727	1,379,727	1,379,727	1,379,727
R-squared	0.675	0.675	0.675	0.675

Note: The sample is restricted to households consuming above the median mean daily kWh in 2006. Each observation is a household-billing cycle. Standard errors 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, and year-month fixed effects. Mean daily kWh are 41.48. Conservative is defined as Republican, American Party, or Libertarian. Liberal is defined as Democrat, Green Party, or Peace and Freedom.

Table 5: Predicted Treatment Effects by Ideology

	Treatment Effect	Std. Err.
Registered liberal, pays for renewable energy, donates to environmental groups, and in Top 75th percentile liberal block group	-0.031***	0.000
Registered conservative, does not pay for renewable energy, does not donate to environmental groups, and in bottom 25th percentile liberal block group	0.007***	0.006
Above median electricity usage in 2006		
Registered liberal, pays for renewable energy, donates to environmental groups, and in Top 75th percentile liberal block	-0.055***	0.003
Registered conservative, does not pay for renewable energy, does not donate to environmental groups, and in bottom 25th percentile liberal block group	-0.004	0.003

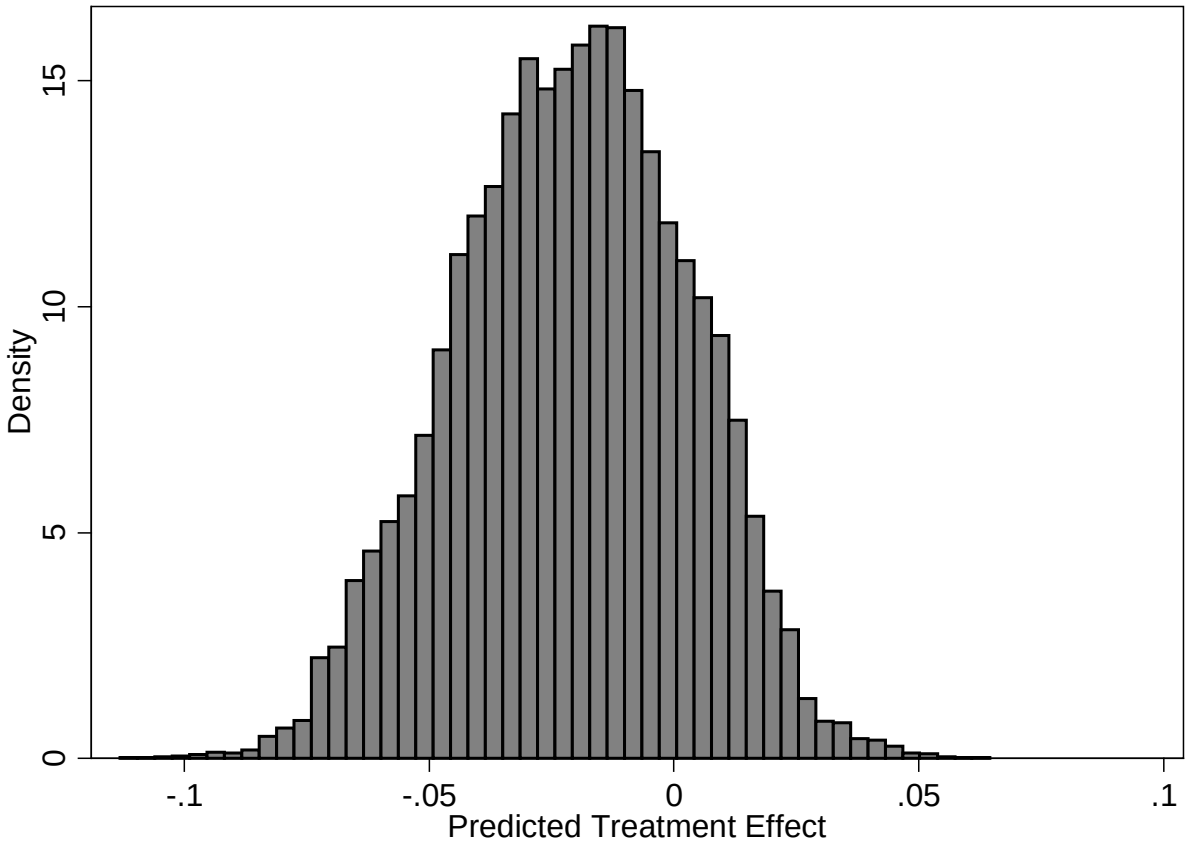
Note: Predicted treatment effects are estimated from Regression 4 in Table 3. *** indicates statistical significance at the 1% level. Everyone in the treatment group is assigned the given characteristics while all other characteristics are kept at their median values. Conservative is defined as Republican,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

Table 6: Decision to Opt Out of Treatment and View of Reports by Ideology

	Dependent Variable =1 if		
	Opt Out	Reports of No Value	Dislike 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. 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.

Figure 1: Predicted Treatment Effects for Every Household in the Treatment Group



Note: Predicted from Regression 4 in Table 3.