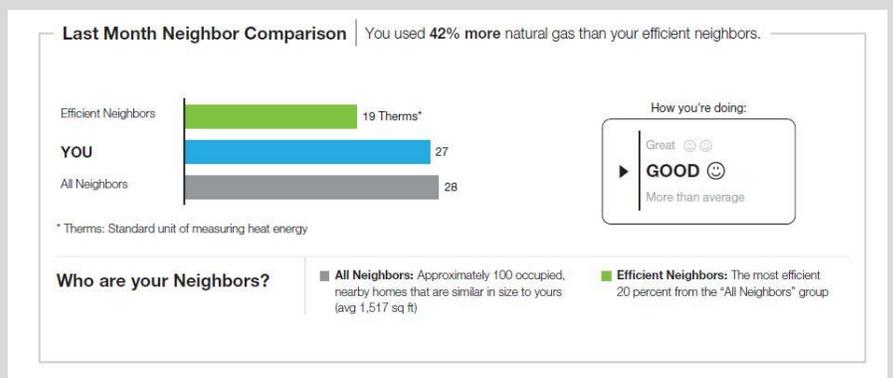


THE WELFARE EFFECTS OF NUDGES: A CASE STUDY OF ENERGY USE SOCIAL COMPARISONS



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BACKGROUND

When implementing any policy, policymakers trade off benefits and costs. This document summarizes a working paper that carries out a full benefit-cost analysis of the second year of an Opower Home Energy Report (HER) program. The program sends neighbor energy use comparisons and energy conservation tips to residential natural gas consumers via direct mail. Home Energy Reports are an important case study of behavior-based conservation: as of mid-2015, Opower was sending HERs to 15 million households and businesses at 95 utility partners in nine countries, generating \$1 billion in energy savings.

HER programs have been evaluated many times in the past. The prior evaluations, however, typically include only program implementation costs and the value of energy saved, ignoring most or all non-energy benefits and costs incurred by consumers, such as money spent on improved insulation or energy efficient appliances, time spent turning off lights or adjusting thermostats,

increased comfort from better-insulated homes or decreased comfort from setting thermostats to energy-saving temperatures, and perhaps even “emotional” benefits and costs from feeling inspired or pressured into energy conservation.

In the language of energy efficiency program evaluators, most prior evaluations use “Program Administrator Cost Tests,” which are incomplete but easier to implement, while we carry out a “Societal Total Resource Cost Test.” To do this, we use revealed preference analysis, a standard tool in economics. The idea is simple: if a consumer is willing to pay \$X for something, she must value it at \$X or more. A consumer’s willingness-to-pay (WTP) for HERs is a comprehensive measure of her perceived net benefits, including the value of retail energy cost savings plus any additional benefits and costs suggested above. In essence, the revealed preference approach is to let people “vote with their wallets.”



STUDY DESIGN

Our research team collaborated with Opower and Central Hudson Gas and Electric to implement the study. Central Hudson is running a standard Home Energy Report program with about 20,000 residential natural gas consumers, split equally between recipient and control groups. The recipient group was mailed up to four HERs during each of the 2014-2015 and 2015-2016 winter heating seasons. Using both mail and phone in summer 2015, we delivered a “multiple price list” survey asking HER recipients to make seven choices between future HERS and checks for different amounts of money. The answers to these seven questions tell us each household’s willingness-to-pay. For example, people who prefer “four more Home Energy Reports plus a check for \$9” instead of “a check for \$10” are giving up \$1 for the four more HERs. People who prefer “a check for \$10” instead of “four more Home Energy Reports plus a check for \$5” are not willing to give up \$5 for four more HERs. People with these preferences must therefore have WTP between \$1 and \$5. Respondents actually received what they chose in one of the seven questions – either a check or a check plus four more HERs – so they had the incentive to respond thoughtfully.

In most previous HER programs, a small fraction of recipients dislike HERs enough to take time to contact their utility and opt out. This suggests that at least some people might be willing to pay to avoid receiving HERs. The multiple price list was therefore designed to allow people to reveal negative WTP. For example, people who prefer “a check for \$9” instead of “four more Home Energy Reports plus a check for \$10” are giving up \$1 to not receive four more HERs, meaning that their WTP must be no greater than \$-1.

In general, respondents appeared to understand the survey format and give meaningful answers. WTP was strongly correlated with answers to additional qualitative survey questions, such as whether the HERs “gave useful information” or could help save more energy.

We chose to elicit WTP for future HERs from past recipients because past recipients are plausibly able to evaluate how much they would like future HERs, unlike people who have never seen an HER. Thus, while WTP could be different for the first year of HERs, our design does not evaluate this. Of course, results could also be different for different populations at different utilities.

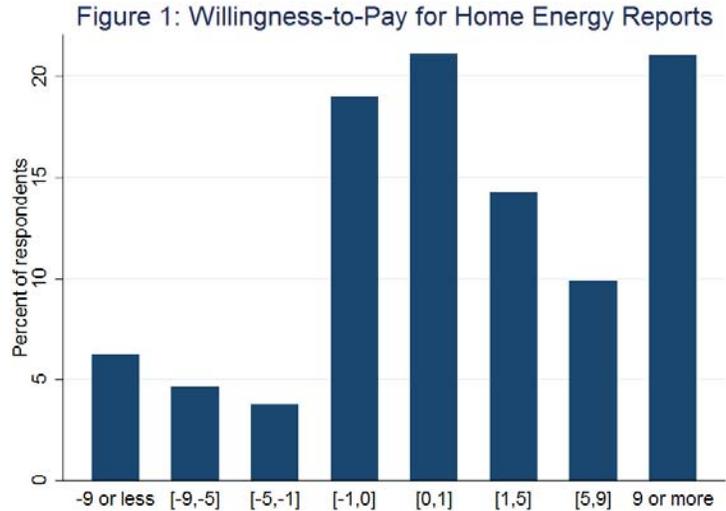


RESULTS

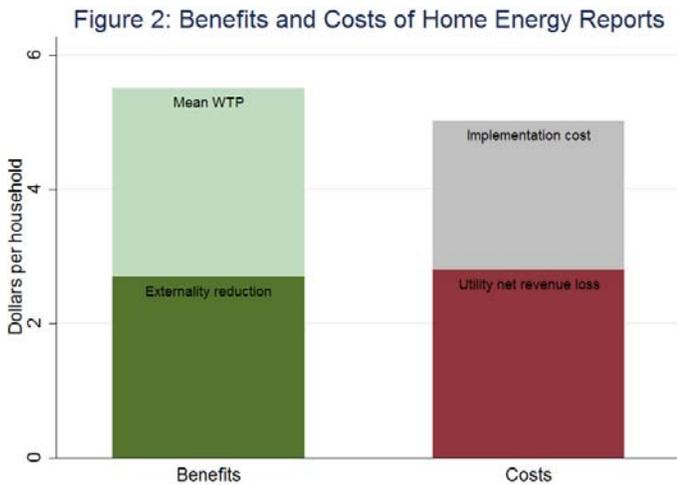
On average, respondents were willing to pay just under \$3 for four more Home Energy Reports

Figure 1 is a histogram of consumers' WTP for four more HERs. Sixty-six percent of households had positive willingness-to-pay, while 34 percent did not want HERs even at zero cost. Average WTP was just under \$3.

This average WTP is about 54 percent of our prediction of average savings. In other words, HER recipient households incur net "non-energy costs" of about 46 percent of retail energy savings. These monetary, time, comfort, or emotional costs are not included in traditional program evaluations such as the Program Administrator Cost Test.



We estimate that the benefits of this program's second year exceed costs by about \$0.49 per recipient



Net social benefit is the sum of WTP across all recipients, plus the value of reduced emissions of carbon dioxide and other pollutants, minus the program's implementation cost and the utility's net revenue loss. Figure 2 summarizes the results. The average WTP of about \$3 per household captures all consumer benefits and costs, including the value of natural gas savings at retail prices. Using standard economic estimates of health costs and other damages, the value of air pollution reductions is \$2.70 per household. We estimate that the cost of delivering a second year of HERs, including printing and mailing plus management time and overhead, is about \$2.22 per recipient household. Central Hudson's net revenue loss – the difference between energy bill revenue and natural gas

acquisition cost – is \$2.80 per household. This net revenue loss decreases the utility's ability to cover fixed costs such as meter reading and maintenance, and these revenues are recovered by charging slightly higher prices to all consumers. (Utilities account for this issue with any distributed generation or energy efficiency program, not just HERs.)



POLICY IMPLICATIONS

The main policy implication is that difficult-to-measure non-energy benefits and costs can make a large difference in program evaluation. Such costs are relevant for all energy efficiency programs, including traditional energy efficiency and other “nudge”-style behavioral interventions. For the second year of this particular program, we estimate that ignoring “non-energy costs” overstates net social benefits by a factor of almost six. Net benefits on regulatory metrics such as the Total Resource Cost Test are also significantly lower once “non-energy costs” are taken into account.

The implications for energy efficiency program choice are somewhat subtle. Central Hudson and many other utilities must comply with Energy Efficiency Portfolio Standards or similar regulations requiring them to induce a specific quantity of energy savings each year. Alternative energy efficiency programs such as home retrofits may or may not have positive net social benefits, and benefit-cost analyses of these programs are also imperfect.¹ Thus, substituting to alternative energy efficiency programs that have not been subjected to a complete benefit-cost analysis may not be better than continuing an HER program, even if the net benefits are less than previously believed.

In the above calculations, the adder to retail marginal prices for fixed cost recovery is slightly larger than mainstream estimates of damages from climate change and local air pollution. In other words, Central Hudson’s marginal retail natural gas prices are slightly higher than our estimate of social marginal cost. Prior research has shown that this not unusual for natural gas utilities across the U.S.² This calls into question the logic of persuading or subsidizing consumers to conserve in order to reduce environmental externalities – the price they pay for natural gas already accounts for those externalities. In our evaluation, Home Energy Reports thus have positive social benefits only because they provide private benefits that consumers value.

Figure 1 suggests that many households value HERs at less than the marginal social cost of providing them, including some who would pay to avoid receiving HERs. In other words, some consumers would not support a utility’s decision to increase their rates in order to send them HERs. A targeted program that does not send HERs to these households could substantially increase net benefits. In theory, there are two ways to achieve this. First, a utility could let consumers opt in to HERs instead of sending them to all consumers that don’t opt out. However, opt-in programs often have very low enrollment rates in a variety of domains, and many people who value a service don’t end up signing up. Because of this “inertia,” we calculate that an opt-in program would have lower net benefits than the current opt-out program. Second, utilities could use demographic information to target opt-out programs to households that are likely to want them the most, dropping the subset of households that are less likely to want HERs. For the Central Hudson program, we find that dropping about 20 percent of the current recipient group would increase net social benefits by 45 percent.

¹ See, for example, Allcott, Hunt, and Michael Greenstone (2015). “Measuring the Welfare Effects of Energy Efficiency Programs.” Working Paper.

² See Davis, Lucas, and Erich Muehlegger (2010). “Do Americans consume too little natural gas? An empirical test of marginal cost pricing.” *RAND Journal of Economics*, Vol. 41, No. 4 (Winter), pages 791-810. This result may also be true for some electric utilities, but the calculation is more involved because long-run marginal costs vary substantially depending on time of use and externalities vary substantially depending on generation source.



ADDITIONAL BACKGROUND

Additional information on the authors

Judd B. Kessler is an Assistant Professor of Business Economics and Public Policy at The Wharton School at the University of Pennsylvania and an Affiliated Professor at Poverty Action Lab. He received a PhD from Harvard University in 2011, an MPhil from Cambridge University in 2005, and a BA from Harvard University in 2004. His website is <http://assets.wharton.upenn.edu/~juddk/>.

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Full Technical Paper

The full technical paper, titled "The Welfare Effects of Nudges: A Case Study of Energy Use Social Comparisons," is available from the authors' websites.

ABOUT US: THE E2E PROJECT'S MISSION AND STRATEGY

Supported by a generous grant from The Alfred P. Sloan Foundation, The E2e Project is a joint initiative of the Energy Institute at the University of California at Berkeley's Haas School of Business, the Energy Policy Institute at Chicago at the University of Chicago, and the Center for Energy and Environmental Policy Research at the Massachusetts Institute of Technology.

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