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Do Energy Rebate Programs Encourage Conservation?

By Koichiro Ito

"Congratulations! You've earned a bonus credit of 20 percent on your winter natural gas bill." If you are a customer of Pacific Gas & Electric (PG&E), you might be among 1.8 million households that received this message in the winter of 2012. Such programs, often called conservation-rebate programs, recently became popular among electric, natural gas, and water utilities. Customers usually do not need to sign up for enrollment. If customers achieve a certain targeted level of conservation relative to their historical consumption level, utility companies automatically issue a bonus credit. PG&E's winter gas rebate program issued a credit for 2.7 million customers in 2011 and 1.8 million customers in 2012. The total bill credit was $70 million in 2011. The primary policy goal of this program is to encourage customers to reduce consumption by giving them an economic incentive. At this point, however, you might ask how much of this spending actually contributed to "conservation" and how much of it did not?

This is exactly why conservation-rebate programs have been controversial since their first implementation. During the California electricity crisis, Governor Gray Davis introduced the 20/20 rebate program in which residential electricity customers obtained a 20 percent bill credit if they could reduce their consumption by 20 percent relative to their consumption a year earlier. This California statewide program provoked controversy over its cost-effectiveness.

Opponents questioned the fairness and effectiveness of the program. For example, Faruqui and George (2006)

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argue that the programs are politically popular but are likely to be inefficient for energy conservation. The first concern is that the program did not account for weather differences between the base year and target year. Therefore, if the target year turns out to be cooler than the base year, many households may receive a rebate simply because of the weather difference. The second concern is that even if there turns out to be no significant weather difference between the two years, many customers will receive a rebate because of random fluctuations in their energy consumption. For example, customers that had a friend visit in the base year or customers that traveled in the target year can reduce their target year's consumption by 20 percent compared with their base year without conservation efforts.

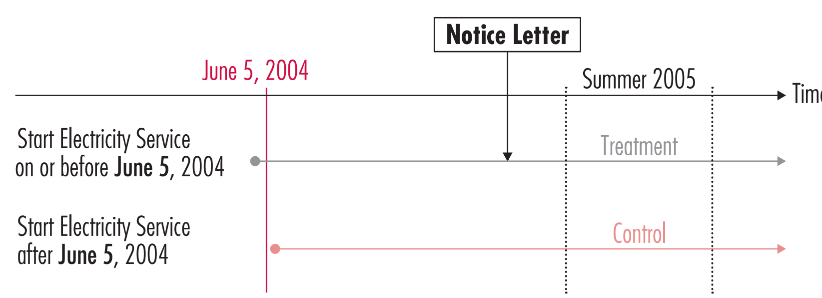
The proponents of the program argued that the simplicity of the program makes it straightforward for customers to understand the incentive and will likely encourage energy conservation. The rebate program was also more politically appealing than alternative pricing policies, such as an increase in electricity price or an introduction of real-time pricing. In contrast to these alternative policies, the rebate program does not make ratepayers feel a large economic burden, even though it will be ratepayers who will eventually pay the program's expenditure as an increase in electricity price.

To examine the cost-effectiveness of the program, first, we need a reliable estimate of the treatment effect that is produced solely by the program incentive. The estimation of this treatment effect is, however, generally challenging with non-experimental data. Obviously, it is misleading to make a conclusion simply by looking at the total consumption reduction achieved by the customers that received a rebate. Some rebated customers received a rebate without any conservation effort on their part; whereas some un-rebated customers may have responded to the program incentive but failed to reach the 20 percent reduction cutoff to receive a rebate. Therefore, comparing rebated and un-rebated customers does not provide much information about the program's treatment effect. The second challenge is how to control for potential differences between the base year and target year that are unrelated to the program. For example, differences in weather conditions and macroeconomic shocks are likely to affect electricity consumption. Therefore, changes in electricity consumption between the two years include the program's treatment effect and other confounding factors that are unrelated to the program. Existing empirical studies find it very difficult to disentangle these confounding factors from the treatment effect because usually there is no counterfactual control group that can be compared with the treatment group.

One of my working papers, Ito (2010), aims to overcome

Figure 1. Program Eligibility Rule for the 2005 California 20/20 Electricity Rebate Program

	CUTOFF DATE
PG&E	June 1, 2004
SCE	June 5, 2004
SDG&E	June 30, 2004



Note: Households that opened their account on or before the cutoff date in 2004 received a notice letter around April 2005 and were automatically enrolled in the 2005 California 20/20 electricity rebate program. These households were eligible for a 20 percent discount on their summer electricity bills if they reduced their electricity consumption by 20 percent relative to their consumption in 2004. Households that opened their account after the cutoff date were excluded from the program. The three electric utilities have slightly different cutoff dates.

this challenge by exploiting a discontinuous eligibility rule in the 2005 California 20/20 rebate program. To be eligible for the 2005 rebate program, customers had to start their electricity service by a certain cutoff date in 2004. Figure 1 illustrates how the eligibility rules were applied to customers. For example, in Southern California Edison (SCE), the cutoff date was June 5, 2004. Therefore, customers that started their electricity service on or before June 5, 2004, received a notice letter in the spring of 2005 for the 2005 rebate program, whereas customers that started their service after the cutoff date (e.g., June 6, 2004) were not eligible for the program in 2005.

The eligibility rule includes two additional key components. First, it was impossible for customers to anticipate the 2005 rebate program when they started their electricity service in 2004 because the program had not been used since 2002, and the eligibility rule for the 2005 program was not announced until the spring of 2005. Therefore, it was not possible for customers to strategically choose their start date across the cutoff date of the program. Second, as long as a customer was eligible for the program, the customer automatically participated in the program without having to apply. This automatic participation rule excludes self-selection for the program. The three electric utilities (PG&E, SCE, and SDG&E) strictly enforced these rules without exception.

This quasi-experimental environment provides the following advantages in estimating the program's treatment effect. The discontinuous eligibility rule generated essentially random assignment of the program among households that started their account near the cutoff date. For example, customers that started their electricity service right before the cutoff date and right after the cutoff date are likely to have similar underlying properties for their electricity consumption, but they were assigned into different groups in terms of the treatment assignment of the rebate program. Even if there is a concern that the underlying properties might be correlated with their service start date, a regression discontinuity design (RDD) can eliminate the bias

Figure 2. Electric Utility Service Areas in California

Note: This figure shows the service areas of electric utilities in California. The original source file is available at the California Energy Commission's website. Three investor-owned electric utilities, Pacific Gas & Electric, Southern California Edison, and San Diego Gas & Electric, participated in the 2005 California 20/20 electricity rebate program.

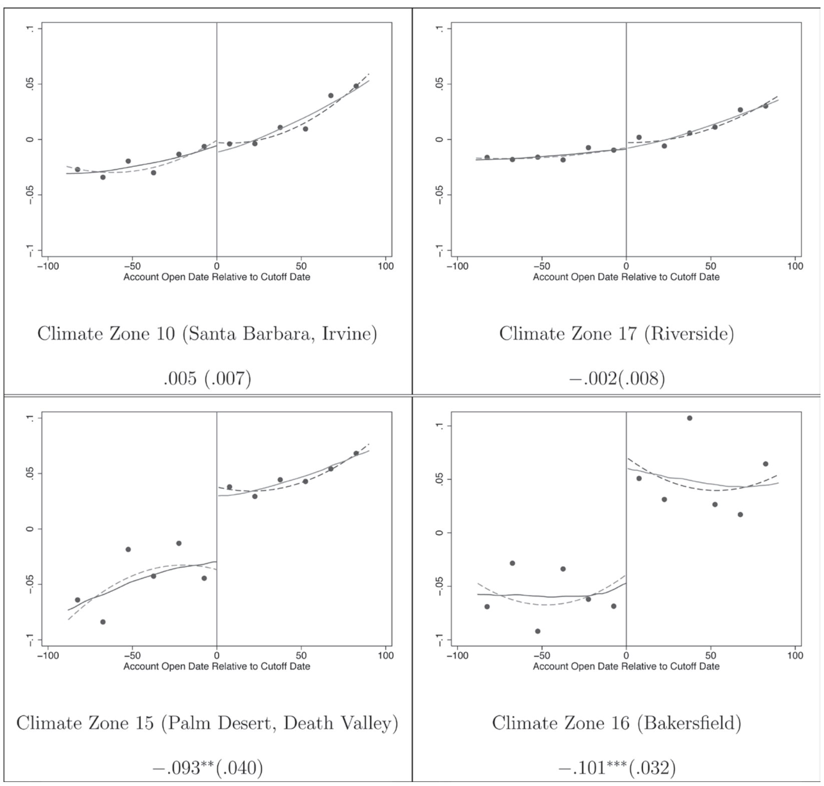
as long as the correlation between unobservable factors of electricity consumption and service start dates is continuous around the cutoff date for the rebate program.

A potential concern is whether this research design can provide enough observations to have sufficient statistical power to quantify the program treatment effect. In California, about 10,000 customers open an electric account per day. Therefore, there are a large number of observations, even if I limit the samples to households that opened an account close to the cutoff date. In addition, because new accounts are generally opened in a wide range of geographical areas in California, the geographical variation allows estimating potential heterogeneous treatment effects in different regions in California.

I apply this methodology to household-level micro data on monthly electricity consumption. The three largest investor-owned utilities (IOUs) in California, allowed me to use household-level monthly electricity billing records of essentially all of their customers, excluding customers' private information. Figure 2 shows the service areas of the three IOUs in this study: PG&E, SCE, and SDG&E. In addition to household-level monthly electricity consumption data, the key variable for the regression discontinuity design of this study is each customer's account open date. The billing records include the exact open and close dates for each customer. For my main estimation, I use customers that open their electricity account within 90 days before and 90 days after the cutoff date.

Throughout the three electric utility service areas, I find that the program induced 5 to 10 percent of consumption reductions in inland areas, while the program had nearly zero effects among customers in coastal areas. For example, Figure 3 illustrates results for a few of SCE's service areas. The top two figures show results for climate zones 10 and 17 in SCE. These climate zones include coastal areas, which have relatively moderate summer climate conditions compared with inland areas.

Figure 3. Regression Discontinuity Estimates: SCE September Billing Month



Note: This figure presents the regression discontinuity estimates for the September billing month in SCE by its climate zones. The horizontal axis shows households' account open date relative to the cutoff date for the program eligibility. The vertical axis shows the log change in September consumption from 2004 to 2005 where zip code level mean and billing cycle level mean are subtracted. Each dot presents the local mean using a fifteen- day window and the solid and dashed lines are the fitted lines, respectively. I also include representative cities for each climate zone in parentheses. Finally, the figure includes the point estimate of the treatment effect with the robust standard errors in parentheses.

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For example, the cities of Santa Barbara, Long Beach, and Irvine are included in these climate zones. The horizontal axis shows the account open date of customers relative to the cutoff date to be eligible for the program. Thus, customers on the left of the cutoff are in the control group and customers on the right of the cutoff date are in the treatment group of the program. The vertical axis shows the percent change in consumption from the summer of 2004 to the summer of 2005. Therefore, if the program had an effect on consumption, we should observe a jump between customers on the left and right of the cutoff date.

The figures provide evidence that the program did not significantly change electricity consumption for the treatment group in the coastal climate zones. The change in electricity consumption has a moderate positive trend in the account open date as discussed in the previous section, but it does not have a discontinuous jump at the cutoff date.

In contrast, the bottom two figures indicate evidence that the rebate program had a significant effect on electricity consumption in climate zones 15 and 16. These climate zones are located in inland areas of southern California, where the summer temperature is persistently high and households typically use an air conditioner throughout the summer.

In a regression framework, I investigate what is the reason for these differences. I find that both climate and income matter. Customers in warmer climate areas and customers in lower income areas are more likely to respond to the program incentive.

Finally, I estiamte the cost-effectiveness of the program. Not surprisingly, the cost-benefit is very poor for coastal areas. The treatment effect is nearly zero, but still some customers received a rebate because of random fluctuations in their electricity consumption. In contrast, the cost-benefit ratio for inland areas is fairly high because the average treatment effect is 5 to 10 percent of consumption reductions. However, because most people in California live in coastal areas, the aggregate cost-benefit turns out to be fairly low and the program is more expensive than estiamted by previous studies.

Should this type of conservation-rebate program continue to be used? The results from my analysis provide a few policy implications to this question. First, the program evaluation should not be solely based on the number of customers who received a rebate because some customers always receive a rebate because of other factors unrelated to the program incentive itself. Second, the program can achieve better cost-effectiveness if policymakers can focus on customers who are more likely to respond to the program incentive, such as households in inland areas or low-income households. Finally, most of the previous rebate programs were simply based on monthly consumption rather than based on peak and off-peak consumption. Now, most residential customers in California have advanced interval meters (smart meters). The cost of electricity is unambiguously more expensive in peak time. Therefore, the demand response program from now on should focus on reductions in peak-time consumption.[1]

References

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1 It is actively debated whether 1) critical peak-time pricing or 2) critical peak-time rebate programs should be used to cut peak-time consumption. Many economists argue that critical peak-time rebate programs have more drawbacks than critical peak-time pricing. Rebate programs always need to be based on some baseline consumption level. The calculation for each consumer’s baseline can be very arbitrary. Furthermore, when the baseline is determined by the customer’s historical consumption level, it could discourage the customer to invest in energy efficient products. Finally, previous studies such as Wolak (2011) find that critical rebate programs produce smaller effects than critical peak-time pricing.

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