Does Increasing Block Pricing Decrease Energy Use? Evidence from the Residential Electricity Market

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Abstract

Many electric utilities in the United States have replaced flat pricing schedules with increasing block prices (IBPs) to decrease aggregate electricity use without imposing costs on low-income households. Under IBPs, the price per kilowatt-hour increases as electricity use increases. It is not clear, however, whether IBPs decrease aggregate energy use and protect low-income households. I use monthly billing records and demographic data to estimate price elasticities of energy demand by income. I use these elasticities to show that IBPs in California increase total electricity use relative to a revenue-neutral flat price. Finally, I find that IBPs decrease electricity bills for low-income households.

Keywords: Electric Utilities; Government Policy; Energy Demand

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1 Introduction

An increasingly common pricing schedule in the United States is increasing block pricing (IBP). IBPs are similar to increasing marginal tax rates: marginal electricity prices increase with electricity use. Electricity prices under IBPs are step functions where high-use households pay high electricity prices and low-use households pay low electricity prices. California introduced the United States' first IBPs in the 1980s with two goals (1) decrease total electricity use and (2) protect low-income households from increasing electricity bills.

In this paper, I ask whether IBPs meet those dual goals of decreasing total electricity use and helping low-income households. The outcome of the first goal, decreasing electricity use, is theoretically ambiguous. States often regulate utilities' returns, meaning that if a utility changes its pricing schedule, the total revenue earned by both pricing schedules should be the same. The utility cannot raise rates for all consumers. As a result, when a utility changes from a flat electricity price per kWh to an IBP, some households experience a decrease in their electricity price while others experience an increase. It is an open empirical question whether decreases in electricity use by high-use households experiencing higher prices are offset by increases in electricity use by the low-use households experiencing lower prices.

The change in total electricity use following the introduction of IBPs depends on three characteristics of the utility and the customers it serves. First, the change depends on the relative price elasticities of electricity demand of households along the pricing schedule. If the households experiencing price decreases are relatively more elastic than the households experiencing increases, total electricity use would increase.

Second, whether IBPs decrease total electricity use depends on the distribution of households across the IBP. If there are more households on the lower tiers of the IBP experiencing price decreases, IBPs are more likely to increase total electricity use. Of course, that distribution also depends on the characteristics of the IBP such as where the prices increase and what those prices are.

Third, a central issue for all nonlinear prices is whether households respond to marginal or average prices. This problem is particularly relevant for electricity because consumers may not know their electricity price. High marginal prices send a strong signal for conservation only if households actually respond to those prices. Average prices send a weaker signal for conservation because average prices are less than or equal to marginal prices. Recent evidence finds that households respond to average prices rather than marginal prices (Ito 2014; Wichman 2014).

To answer whether IBPs decrease total electricity use, I examine all three aforementioned characteristics for two California utilities using two data sources. The first is the Residential Appliance Saturation Study (RASS) from 2003 and 2009, which contains monthly household electricity use and detailed demographic data for a sample 46,490 households. The second, which I compiled, contains historical electricity prices for two major public utilities in California, Pacific Gas and Electric (PG&E) and San Diego Gas and Electric (SDG&E).

The detailed electricity and demographic data from the RASS allow me to estimate price elasticities that vary by income for both marginal and average price response assumptions. Price elasticities that vary by income capture heterogeneity in household price sensitivity important to determining whether IBPs increase or decrease total electricity use. In addition, elasticity estimates by marginal and average price yield a range for the effect of IBPs on total electricity use.

A main challenge in my analysis is that electricity use endogenously determines electricity prices for two fundamental reasons. The first is the common simultaneity problem: the equilibrium of electricity supply and demand yields the electricity price and quantity. When, or where, electricity demand is high, utility companies charge high prices. The second simultaneity problem results from the IBPs themselves: per-unit electricity prices increase with electricity use. A simple ordinary least squares regression of electricity price on electricity use would show a positive correlation between the two, the opposite of what standard consumer demand theory predicts.

To address these endogeneity problems and estimate price elasticities by income, I combine cross-sectional and temporal variation in electricity prices in an instrumental variables approach. Utility companies occasionally update their electricity prices, driving temporal variation. Utility companies also charge geographically differentiated electricity prices within their territories, driving cross-sectional variation. To estimate elasticities I limit the sample geographically to households living close to pricing zone borders. While geographic discontinuities in energy policies have been used before to estimate policy outcomes, such as energy savings from building codes, this paper is the first to use within-utility differences in electricity prices to estimate price elasticities of electricity demand.[1]

This instrument, known as a simulated instrument in the taxation literature, predicts a household's current electricity price based on historical electricity use (Auten and Carroll 1999). The resulting elasticity estimates show that high-income households are more price elastic than low-income households. I estimate these elasticities under both marginal and average price response assumptions to bound the effect of IBPs on total electricity use. For example, if households respond to marginal price, elasticities range from -0.100 for poor households with incomes less than $49,999 to -0.427 for wealthy households with incomes greater than $150,000. If households respond to average price, price elasticities of demand range from -0.143 for poor households to -0.362 for wealthy households.[2]

I use the elasticity estimates to answer this paper's central question, whether IBPs decrease total electricity demand. Both of the utilities in the sample charge households IBPs for their electricity. I take those existing IBPs as given and simulate electricity use under an alternative revenue flat price that raises the same revenue as the existing IBP. That counterfactual electricity use allows me to compare total electricity demand under IBPs with total electricity demand under the alternative pricing schedule.

The outcome depends on whether households respond to marginal prices, which may not be salient, or average prices, which ratepayers can intuit from their end-of-month electricity bills. If households respond to marginal prices, IBPs would have decreased total electricity consumption by 4.12 percent relative to a revenue-neutral flat price. That finding meets the IBP policy goal of reducing electricity use. If instead households respond to average price, the results show that IBPs would have increased total electricity consumption by 0.38 percent relative to a revenue-neutral flat price. In both cases, lower-use households experience a price decrease and use more electricity. But in the case of average-price response, even some of the higher-use households, the ones just above the threshold for the rate increase, misperceive their electricity prices to be lower under the flat price and consume more electricity. If consumers respond to average price, IBPs are ineffective at decreasing total electricity demand.

1. See Levinson (2016) and Bruegge, Deryugina, and Myers (2019) for further discussion.

2. Auffhammer and Rubin (2018) estimates price elasticities of natural gas demand that vary by season and by income. That paper finds that households are price inelastic during the summer months but that low-income households, defined by their CARE status, are more price elastic than high-income households in the winter months.

One advantage of these data is that I have demographic information that allows me to estimate elasticities of demand by household income. However, the disadvantage of using the survey with detailed demographic data is that the sample size is small. As a result, not all of the elasticity estimates by income are statistically distinguishable from each other. For this reason, I include robustness tests for the change in electricity demand using the upper and lower confidence interval for each elasticity estimate. In addition, I complete the same analysis using only the average elasticity estimate for the full sample. Both of these tests show the same qualitative results: electricity use increases under IBPs relative to flat prices if households respond to average prices.

The result that California's IPBs increase electricity consumption if households respond to average price does not hinge on the particular elasticities estimated here. I run the same experiment—comparing actual electricity demand with IBPs to predicted demand with flat prices—using elasticities calculated by previous researchers (Ito 2014; Reiss and White 2005). Using either alternative set of elasticities, I find similar results. IBPs increase electricity use if customers respond to end-of-month average electricity prices.

After determining that IBPs are unlikely to meet their goal of decreasing total electricity use, I assess whether IBPs achieve the second goal of protecting low-income households from high electricity bills. The answer to this question depends on two features of the relationship between income and electricity.

The first is the correlation between income and electricity use. Utilities that use IBPs to target low-income households implicitly assume these households use less electricity, which may not be the case. The detailed survey data in the RASS allow me to assess the relationship between income and electricity use while taking into account other household characteristics, like appliance ownership and weather. There is a small positive correlation between income and electricity use of 0.093 conditional on appliance ownership, weather, and other household characteristics. This small correlation suggests that electricity use is a poor proxy for income, some low-income households are high-electricity users and vice versa. Therefore, IBPs may not be an effective tool for helping low-income households.

The second is the presence of existing programs to provide bill assistance to low-income households. In California, a program called California Alternate Rates for Energy (CARE) provides per-kWh discounts on electricity prices to low-income households. Low-income programs directly target income while IBPs can only target electricity use and may therefore be more effective at helping low-income households. I simulate electricity bills under an alternative revenue-neutral flat pricing regime with a special low-income discount rate to evaluate whether, and if so, how much IBPs help low-income households. IBPs with CARE save the median low-income household an additional $6.25 per month, or 11.94 percent, on their electricity bills relative to flat prices with low-income rates.

For the final analysis, I calculate changes in welfare from using IBPs rather than flat prices assuming that households respond to marginal electricity prices. IBPs distort electricity prices. Different households pay different electricity prices that do not reflect differences in the cost of provision. IBPs generate deadweight loss relative to flat prices because of this distortion. In addition, California's electricity prices are higher than the social marginal cost of electricity generation (Borenstein and Bushnell 2018). Using IBPs instead of a revenue-neutral flat price generates $0.64 of deadweight loss on average per month per household. Using IBPs instead of a flat price equal to California's social marginal cost of electricity generates $3.85 of deadweight loss on average per month per household.

This paper makes several contributions. First, this is the only paper to estimate price elasticities of electricity by income assuming that households respond to average price. Previous papers have estimated elasticities by income assuming that households respond to marginal prices by using annual survey data with income and predicting monthly electricity use,[3] or by using monthly electricity data and predicting income based on the household's location.[4] The RASS data contain both monthly electricity use and income, mitigating any concerns over measurement error in predicting either electricity use or income.

Second, this paper demonstrates that IBPs increase total electricity consumption if households respond to average price. Almost 1,300 utilities in the U.S. use IBPs and China switched to IBPs in 2012, demonstrating that IBPs are common both in the U.S. and around the world (Levinson and Silva 2018; Zhang, Cai, and Feng 2017). These results suggest that utility regulators must understand the households they serve in order to avoid the unintended consequence of increased electricity use. Third, the novel identification strategy used in exploiting within utility pricing

3. Alberini, Gans, and Velez-Lopez (2011); Reiss and White (2005)

4. Borenstein (2012b)

borders has not been used in the past to estimate price elasticities of electricity demand. This intrautility strategy could be more widely applied to estimate the effects of other energy policies.

Fourth, this paper finds that IBPs do slightly decrease electricity bills for low-income households. Three other papers ask this question. The first, Borenstein (2012b), uses monthly electricity use and predicted income data to show IBPs do some redistribution but CARE is a more efficient program for redistribution. However, that paper estimates household income from census block income data rather than measuring it directly. The second, Borenstein and Davis (2012) uses data from the Residential Energy Consumption Survey and the RASS to show that the correlation between natural gas use and income is only weakly positive. The third, Levinson and Silva (2018) estimate an "electric Gini." The electric Gini measures how redistributive electricity prices are, finding that utilities with more unequal income distributions have more progressive electricity prices. Their paper, however, does not have detailed electricity use data for the households served by the utilities in their sample.

2 Empirical Setting

2.1 California's IBPs and Data

This study focuses on households served by two of the three major investor-owned utilities in California: San Diego Gas and Electric (SDG&E) and Pacific Gas and Electric (PG&E). SDG&E and PG&E are two of the largest utilities in the United States. In 2003, one of the years in this study, SDG&E served 1.1 million households and PG&E served 4.3 million households.

Each household's electricity price depends on the month, the location, and how much electricity it consumes. Each location-specific IBP has a different kWh threshold for the first tier, called a "baseline," and subsequent rate increases occur at 130 percent, 200 percent, and 300 percent of that baseline. The baseline is set by historical average monthly electricity use by households within region with the same climate, known as a climate zone.[5]

Figure 1 depicts an example for June 2009 for PG&E's climate zone T. This IBP has five tiers, ranging from 11 to 44 cents per kWh. The height of each tier represents the price per kWh a

5. The California Public Utilities Commission (CPUC), together with the utility companies, determines these climate zones.

household pays; these are the same within a utility. The width of each tier depends on the baseline Tier 1 threshold at which prices increase; these vary within a utility. In the example in Figure 1, the baseline allocation is 253 kWh. Households pay 11 cents per kWh for electricity use up to 253 kWh (the baseline), 13 cents from 253 up to 329 kWh (130 percent of 253), 26 cents from 329 up to 506 kWh (200 percent of 253), 38 cents from 506 up to 759 (300 percent of 253), and 44 cents above 759 kWh.

Figure 1 also shows the average price the household pays as a function of its electricity consumption, represented by the dashed line. The average price is the same as the IBP for the first tier, and then increases more slowly than the IBP for higher tiers. For example, a household using 436 kWh per month, which was average electricity use in PG&E Zone T in June 2009, would pay 26 cents for the 437th kWh. The average price across all 437 kWh would be 15.3 cents per kWh. The total monthly electricity bill would be $66.91.

More generally, each utility has a set of tiered rates. Figure 2 shows the five tiers from 2001 to 2009 for SDG&E. Figure 3 does the same for PG&E. Each utility has multiple climate zones with different baseline electricity allocations, determining where the prices jump from one tier to the next. SDG&E has 4 zones (Figure 4) and PG&E has 10 (Figure 5). Figures 6 and 7 show those baseline allocations for each climate zone in SDG&E and PG&E, respectively. Baselines are generally lower in coastal regions and higher in inland regions.[6]

Table 1 shows electricity prices and bills in my sample in 2003 and 2009. These averages represent the average across climate zones for tiered prices. In 2003 and 2009, the average Tier 1 rate was 11 cents per kWh. From 2003 to 2009, the average Tier 5 rate increased from 21 to 32 cents per kWh. Household electricity bills, taking the average across all households in the sample, were around $80 in 2003 and $103 in 2009. Both electricity prices and electricity bills increased from 2003 to 2009.

Most California households face price structures like the one in Figure 1. The main exceptions are households in the California Alternate Rates for Energy (CARE) program. CARE offers low-income households 25 to 30 percent discounts on their electricity prices. In all empirical estimates in this study, I account for household CARE eligibility based on income thresholds. Around 1.4 million

6. This difference reflects the fact that baselines are set so households in different climate zones pay roughly the same amount for electricity. Households living farther inland experience warmer weather and therefore use more electricity on average as a result of air conditioner use.

PG&E customers were eligible for CARE in 2015.[7] CARE prices are lower than IBP rates and have two tiers rather than the standard five. In PG&E in June 2009, for example, CARE households paid 8 cents per kWh up to the baseline allocation and 10 cents per kWh for all electricity use above the baseline allocation.

2.2 Household Electricity Use Data

Household electricity data come from the RASS. The RASS, funded by the California Energy Commission, surveyed the electricity use of a representative sample of California households in 2003 and 2009. The survey contains information on household demographics, physical characteristics of the house, monthly electricity use, and monthly gas use for an average of 16 months for each household in each survey round. Across both surveys, the sample consists of 46,490 households and of those, 18,231 are served by SDG&E or PG&E and therefore are part of this study.[8] Utility companies then match and verify the household electricity consumption data.

I focus on single-family homes and exclude the top and bottom 1 percent of electricity users and households with missing data for income or the years their homes were built. The final data set includes 11,622 households and 189,960 monthly electricity use observations.[9]

Each household can be matched to its monthly IBP using the household's climate zone designation. I use the household-specific electricity consumption data combined with location-specific electricity prices to calculate total monthly bills, marginal electricity prices, and average electricity prices for each household for each month. This combined data set contains not only monthly electricity use, which is standard in the literature, but also detailed demographic information. That detailed information is key to determining whether IBPs meet their goals of conserving electricity and helping low-income households.[10]

The average household in the sample used 582 kWh per month in 2003 and 618 kWh per month

7. Source: `https://www.pge.com/en/about/newsroom/newsdetails/index.page?title=20151012_thousands_of_energy_customers_could_receive_more_than_30_percent_in_energy_savings_through_pge_care_program` (accessed February 20, 2018).

8. The RASS also surveys households living in the Southern California Edison and Los Angeles Department of Water and Power utility service territories. However, I was not able to obtain accurate historical pricing data for either of these utilities and drop these households from the sample.

9. For a more detailed description of the data see Appendix A.1.

10. Many studies use utility-level panel data: see Ito (2014), Borenstein (2009), and Wichman (2017). Similarly, surveys that contain detailed demographic information do not report monthly electricity use. See Reiss and White (2005) and Alberini, Gans, and Velez-Lopez (2011).

in 2009. The houses are, on average, 1,900 square feet and 35 years old. Table 2 shows additional descriptive statistics for the households in the sample.[11]

2.2.1 Low-Income Rates

While IBPs are intended to help low-income households, the California Public Utilities Commission (CPUC) mandates a low-income bill assistance program, known as CARE. Any utility with more than 100,000 customers must provide 20–35 percent discounts on gas and electricity bills for eligible households.[12]

The CPUC determines income thresholds for CARE eligibility based on household income and size. If a household's income is below the threshold for its family size, it can enroll in CARE.[13] I observe both household income and size in the RASS and therefore can determine whether each household is eligible for CARE rates. I use this information to match all CARE-eligible households in my sample to the special CARE electricity prices.

Using both CARE and non-CARE rates is key to determining whether IBPs help low-income households. Borenstein (2012b) finds that the presence of CARE decreases the redistribution from IBPs by more than 50 percent.

2.3 Empirical Challenge

To establish whether IBPs decrease total electricity use and help low-income households, I first estimate price elasticities of electricity demand by income. Consider a naive first-differences specification to estimate price elasticities:

$$\Delta ln(kWh_{it}) = \beta_0 + \delta\Delta ln(P_{it}) + \beta_1\Delta X_{it} + \gamma_i + \tau_t + \eta_{it}. \tag{1}$$

where $\Delta ln(kWh_{it}) = ln(kWh_{it}) - ln(kWh_{it_{12}})$ is the log-difference in electricity consumption from month t to month $t-12$; $\Delta ln(P_{it}) = ln(P_t(kWh_{it})) - ln(P_{t_{12}}(kWh_{it_{12}}))$ is the log-difference in

11. Levinson (2016) confirms that the RASS is a representative sample of California households by comparing the RASS with the American Housing Survey and the Residential Energy Consumption Survey.

12. See `https://www.cpuc.ca.gov/General.aspx?id=976` (accessed May, 20 2019).

13. Not all households that are eligible for CARE enroll in the program. In 2015, PG&E estimated that roughly 200,000 of 1.4 million eligible households did not sign up for the program. Source: `https://www.pge.com/en/about/newsroom/newsdetails/index.page?title=20151012_thousands_of_energy_customers_could_receive_more_than_30_percent_in_energy_savings_through_pge_care_program` (accessed February, 20 2018).

price per kWh, either average or marginal, from month t to month $t-12$; $\Delta X_{it} = X_{it} - X_{it_{12}}$ is the difference in weather from t to month $t-12$; γ_i is a border fixed effect; τ_t is a month-of-sample fixed effect; and $\eta_{it} = \epsilon_{it} - \epsilon_{it_{12}}$ is an idiosyncratic error term. Estimates of δ would represent the price elasticity of electricity demand.

There are two primary problems with estimating elasticities via equation (1). The first is the standard simultaneity problem: equilibrium electricity prices and demand are determined jointly. The second is related to the structure of IBPs: under IBPs, a household's electricity price is determined by the quantity of electricity it uses. One additional problem introduced by the first-differencing is that the independent variable, $\Delta ln(kWh_{it})$, represents the growth rate in electricity use between two months. If high and low electricity users have different growth rates in electricity use, the price-elasticity estimate will be biased.

Estimates of δ from equation (1) are reported in Table 3 for both marginal and average prices.[14] Using either marginal or average price suggests that demand curves are upward sloping: consumers use more electricity as prices increase. This positive relationship, however, is a result of the two simultaneity problems. For example, these estimates suggest that for a 1 percent change in average price, electricity use would increase by 1.65 percent. Similarly, for a 1 percent change in marginal price, electricity use would increase by 0.68 percent.

2.4 Estimating Price Elasticities Using Climate Zones

To address the two simultaneity problems present in equation (1), I use an instrumental variables approach by combining cross-sectional and temporal variation in electricity prices. Cross-sectional variation arises from utilities charging different households different prices based on each household's location. Temporal variation arises from utilities' changing electricity prices over time.

Households using the same amount of electricity but living in different climate regions pay different electricity prices. For example, two of PG&E's largest climate zones are Zones T and X. Zone T runs along the coast from Mendocino to San Luis Obispo, while Zone X is the same length but inland. In June 2009, the baseline allocation in Zone X was 369 kWh per month, which is warmer, and the baseline allocation in Zone T was 253 kWh per month. The lower baseline

14. Omitted covariates for the regression on average price can be seen in Table B.1 and for marginal price in Table B.2.

allocation in Zone T corresponds to higher electricity prices for households in Zone T, which can be seen in Figure 8. These higher prices are a result of the fact that the IBP increases more quickly for Zone T households because the baseline allocation is lower.

Suppose there were two households that used 650 kWh in June 2009, one in Zone T and the other in Zone X. For an additional kWh, the Zone T household would have paid 38 cents (on the fourth tier) and the Zone X household would have paid 26 cents (on the third tier). The average price per kWh in Zone T would have been 21 cents versus 16 cents in Zone X. These differences in price would correspond to a \$140 electricity bill in Zone T and a \$101 electricity bill in Zone X.

Temporal price variation results from electric utilities updating both the utility-wide prices and the baseline allocations. These changes in prices over time can be seen in Figures 2 and 3 for SDG&E and PG&E, respectively. Electricity prices fluctuate seasonally and are increasing over time for both utilities.

The changes to the baseline allocations can be seen for SDG&E in Figure 6 and for PG&E in Figure 7.[15] These changes primarily reflect seasonal changes in baseline allocations: baseline allocations are higher in summer than in winter. The immediate implication of pricing by climate zone is that for the same electricity use, households living on opposite sides of the climate border pay different prices that change differentially over time.

I use this cross-sectional and temporal variation in a two-stage least squares strategy to identify the price elasticity of electricity demand. I use a price instrument proposed by Auten and Carroll (1999) and used in Ito (2014). The price instrument is $\Delta ln(\tilde{P}_{it}) \equiv ln(P_t(kWh_{i0})) - ln(P_{t_{12}}(kWh_{i0}))$, where kWh_{i0} represents the kWh consumed in the first month the household is in the sample and $P_{t_{12}}$ is the pricing schedule from 12 months prior to month t. This represents the change in price a household i *would have* experienced for energy use kWh_{i0} from month $t-12$ to month t if it had used the same amount of electricity in both months (Auten and Carroll 1999).[16]

15. A household's climate zone is determined by its location and altitude, so the boundaries are not as clear as they appear to be in these figures. However, the RASS reports each household's climate zone so I am able to match each household with the appropriate pricing schedule for its climate zone.

16. We can use alternative choices for the constant level of electricity consumption to generate alternative instruments. The first is electricity use from a period in the middle. For example, if we are measuring the change in price from January 2000 to January 2001, we would use consumption in June 2000. Another alternative would be to use mean electricity consumption. Using the mean helps lessen the impact of transitory shocks and mean reversion in electricity use. See Blomquist and Selin (2010), Saez, Slemrod, and Giertz (2012), and Ito (2014) for further discussion of these alternative instruments. Using any one of these three instruments requires different assumptions on the structure of the error term.

I estimate the price elasticity of electricity demand via two-stage least squares. The first stage estimates changes in electricity household prices as a function of exogenous, utility-driven changes in electricity prices.

First stage:

$$\Delta ln(P_{it}) = \pi_0 + \pi_1 \Delta ln(\tilde{P}_{it}) + \sum_{j=1}^{10} D_{itj} + \pi_2 \Delta X_{it} + \gamma_i + \nu_{it} \tag{2}$$

The second stage estimates changes in electricity use as a function of the predicted changes in electricity price from the first-stage estimation.

Second stage:

$$\Delta ln(kWh_{it}) = \beta_0 + \delta \widehat{\Delta ln(P_{it})} + \sum_{j=1}^{10} D_{itj} + \beta_1 \Delta X_{it} + \gamma_i + \eta_{it} \tag{3}$$

where $\widehat{\Delta ln(P_{it})}$ is the predicted log-change in price from the first-stage regression based on the simulated instrument $\Delta ln(\tilde{P}_{it})$. In the first-stage regression, π_1 represents the relationship between the instrument, $\Delta ln(\tilde{P}_{it})$, and the observed log-change in electricity prices over 12 months. As in Ito (2014), I add a dummy variable equal to 1 if electricity use is in decile j, D_{itj}, to control for differences in the growth rate of electricity consumption between high and low users. Identification of this dummy variable comes from different households using the same amount of electricity but paying different prices based on where they live. $\Delta X_{it} = X_{it} - X_{it_{12}}$ is the difference in weather from t to month $t-12$. Following Black (1999), I include a border fixed effect, γ_i, to control for time-invariant unobservable differences between the regions in my sample. The border fixed effect controls for differences for households living along one climate border versus another. For example, this fixed effect controls for differences between a coastal to inland border (like T versus X in Figure 5) versus an inland versus mountain border. Last, an idiosyncratic error term, $\eta_{it} = \epsilon_{it} - \epsilon_{it_{12}}$. The coefficient, δ, is the estimated price elasticity of electricity demand. First differencing eliminates household-by-month fixed effects.

I estimate the instrumental variables regression on two different sub samples of data. The first is a limited geographic sample of households that live within 10 km of the closest climate border. This method relies on the assumption that households living nearby are similar and are not sorting across the climate border based on electricity prices. Bruegge, Deryugina, and Myers

(2019) show that households living close to California Energy Commission climate borders use similar amounts of electricity. Balance tests for household characteristics across climate zones can be seen in Appendix Table B.3 through B.7. Trimming the sample at 10 km improves balance on some observable characteristics of the households. However, the balance between characteristics remains imperfect. Thus, using the first differencing strategy to control for time-invariant differences between households is important.

The second method of identifying the effect of prices on electricity demand is simple one-to-one matching on observable household characteristics. Using this alternative sample serves as a robustness check to using households immediately across the border. The wealth of information in the RASS allows me to compare similar households living throughout the climate zones, rather than only across the border. Balance tests for the matched sample for household characteristics between zones in PG&E's and SDG&E's service territory can be seen in Appendix Table B.8 through B.12.

Within each sample, I estimate heterogeneous price elasticities for four different income groups. Rather than estimating elasticities by electricity use, this paper estimates elasticities by income. Because IBPs were intended to protect low-income households, understanding how price sensitivity varies by income group is a key parameter of interest.

3 Results

3.1 Price Elasticities

Table 4 reports the estimates of π_1 from the first-stage regression, equation (2), for both marginal and average prices. These estimates are using the geographically limited climate-border sample. For the regression on average price, a 1 percent increase in the log-difference in the "simulated" average price results in a 0.84 percent increase in the log-difference in the actual average price. I split the sample into the four income groups and estimate the first-stage regression again separately for each group. The correlation between the price instrument and the actual change in price remains strong and positive.

For marginal price, a 1 percent increase in the simulated marginal price results in a 0.62 percent increase in the log-difference in the actual marginal price. All F-statistics are greater than 10, suggesting a strong first-stage relationship. The correlation is stronger for the average price instrument because the average prices generated by IBPs do not have the big jumps in price that the marginal prices do.[17]

Table 5 reports the estimates of price elasticities of demand using the geographically limited sample and the instrument based on the first period of consumption, kWh_{i0}.[18] The first column reports the estimates for price elasticities of demand if households respond to average price. I find that a 1 percent increase in the average electricity price causes households to decrease their electricity consumption by -0.16 percent. The second column reports the estimates for price elasticities of demand if households respond to marginal price.

Next, I split the sample into four different income groups and estimate price elasticities separately by income. I find that low-income households are slightly less price elastic than high-income households. The price elasticities of demand reported in Table 5 range from -0.100 for households with income from $0 to $49,999 to -0.427 for households with income greater than $150,000. Wealthier households are more price elastic than lower-income households.[19]

A 1 percent increase in marginal price causes a -0.143 percent decrease in electricity consumption, if households respond to marginal price. Again, higher-income households are more price elastic than lower-income households. Price elasticities of demand range from -0.107 for households with income from $0 to $49,999 to -0.362 for households with income greater than $150,000. Elasticities estimated by previous studies range from 0 to -0.6 (Reiss and White 2005). The estimates in Table 5 are within this range.[20]

High-income households may be more price elastic than low-income households for several reasons. First, high-income households are likely to have more extraneous uses for their electricity consumption than low-income households. Low-income households are likely using their electricity at subsistence levels for running the lights, the refrigerator, and the air conditioner just to keep their

17. I am not able to distinguish whether households respond to marginal or average prices. The households in my sample all live in the same utility service territory so there is not enough variation between average and marginal prices to estimate an encompassing test as in Ito (2014).

18. Omitted covariates for the regression on average price can be seen in Appendix Table B.13 and for marginal price in Appendix Table B.14. Robustness checks for 5 km and 20 km can be seen in Appendix Tables B.15 and B.16. An additional robustness check using an alternative income grouping can be seen in Appendix Table B.17.

19. Appendix Table B.18 shows estimates from a regression where all income groups are included in the same regression. This specification allows me to test whether the point estimates are statistically different from one another. This table shows that the income group estimates are not statistically distinguishable.

20. Appendix Table B.19 shows the estimates grouping households by electricity use rather than by income. This table shows that households in the 2nd quartile of electricity use have the highest price elasticities of demand relative to the other quartiles.

home at a bearable temperature. While high-income households are more likely to have heated pools and air conditioners set to lower temperatures. High-income households are also more likely to be able to make energy efficiency investments. Thus, high-income households have more margins on which they can adjust their electricity use than low-income households. Appendix Table B.20 shows the marginal effect of air conditioner ownership on a household's price elasticity of demand. These results show that households with air conditioners are slightly more price elastic than households without air conditioners, but that the difference in the elasticities is not statistically significant.

In all estimates in Table 5, the price elasticities for lower-income households are not statistically significant. Many of these households qualify for California's low-income pricing program, CARE. As previously mentioned, CARE provides 25 to 30 percent discounts on electricity prices both by charging lower per-unit prices and by using a two-tier IBP rather than a five-tier IBP. These CARE households do not experience many changes in electricity prices over time. So the variation in prices for these households is smaller, which decreases the statistical precision of my estimates.

It seems likely that households respond to the prices they faced in the previous month rather than the current month, for which they have not yet been billed. To account for this possibility, I estimate equation (3) with respect to last month's price rather than the current price. Appendix Table B.21 shows the resulting estimates for the full sample and by income group. Using the lagged price yields slightly larger elasticity estimates than using the contemporaneous price. While it's possible households respond to their bills last month rather than the prices today, I use the results in Table 5 because they yield more conservative estimates of the change in aggregate electricity demand. However, the remainder of the paper includes robustness checks using the alternative elasticities under the lagged price.

It is still possible that the first period of electricity consumption, kWh_{i0}, is correlated with the error term $\eta_{it} = \epsilon_{it} - \epsilon_{it_0}$ (Ito 2014). This correlation could arise from mean reversion in electricity consumption: if a household has a positive use shock in its first month in the sample, typically its electricity use will drift back down over time, leading to correlation between errors over time. Other simulated instruments based on average electricity use, $\overline{kWh}_i$, and the month in the middle, kWh_{it_6}, have been suggested (Blomquist and Selin 2010; Saez, Slemrod, and Giertz 2012). Appendix Table B.22 reports estimates of price elasticities using the household's average monthly electricity use, $\overline{kWh}_i$. Appendix Table B.23 reports estimates of price elasticities using the month in the middle of the two end months, kWh_{it_6}. The month in the middle, for example, would be June 2009 if the log-difference is for December 2008 to December 2009. The elasticity estimates reported in Appendix Tables B.22 and B.23 show a pattern similar to that of the main elasticity estimates in Table 5.

These elasticity estimates are also robust to using the alternative matched sample. The matched sample is generated by matching households between climate zones using simple one-to-one nearest neighbor matching. Appendix Table B.24 reports the main estimates using the matched sample for both average and marginal prices using the household's initial electricity consumption, kWh_{i0}. Appendix Table B.25 reports the elasticity estimates using the matched sample and the average electricity use instrument, $\overline{kWh}_i$. Appendix Table B.26 reports the elasticity estimates using the matched sample and the price instrument based on electricity use in the middle month, kWh_{it_6}.[21] The price-elasticity estimates using the matched sample and different versions of the price instrument yield qualitatively similar results.

3.2 Finding the Counterfactual Flat Price

To determine whether IBPs decrease total electricity use, I compare actual electricity use under the existing IBP with electricity use under a flat price that raises the same revenue as that IBP. Utility companies' rates of return are regulated, so any price changes must raise the same revenue as the price schedule they are replacing. Thus, electricity use must be compared under two alternative pricing schedules that raise the same revenue. The procedure that follows is similar to a strategy frequently used in the public finance literature to compare outcomes under *revenue-neutral* tax changes.

The equation below takes price-elasticity estimates from Table 5 into account to hold revenue neutral between both pricing scenarios. The following approximation calculates a flat price, $\bar{p}$, that

21. Appendix Table B.27 through appendix Table B.32 show the elasticity estimates for each income group for each climate zone pair used to generate the weighted averages in appendix Tables B.24 through B.26.

raises the same revenue, R, as the block price, $s(p_i)$:

$$\begin{aligned} R &= \sum_i^N D_i(\bar{p}) * \bar{p} \\ &= \sum_i^N \Big[D_i(s(p_i)) + (\bar{p} - s(p_i))\delta_j \frac{D_i(s(p_i))}{s(p_i)} \Big] * \bar{p} \end{aligned} \tag{4}$$

where R is utility revenue, i is a consumer index, $\bar{p}$ is the revenue-neutral flat price, $D_i(\bar{p})$ is electricity demand under the flat rate, $D_i(s(p_i))$ is electricity demand under the current multitier rate $s(p_i)$, and δ_j is the price elasticity of electricity demand for the income group j.

Equation (4) is a Taylor series representation of utility revenue from individual consumer demand under the counterfactual flat price $\bar{p}$. The first line of the equation represents the revenue raised by electricity use under the flat price. In the second line, the term in brackets represents electricity demand under the flat price, $\bar{p}$, using the observed electricity demand under the existing IBP, $D_i(s(p_i))$. In my data, I observe R, $s(p_i)$, and $D_i(s(p_i))$. I estimate the price elasticities δ_j, and then I can rearrange equation (4) to solve for $\bar{p}$. Equation (4) takes into account changes in household electricity consumption in response to the change in price from $s(p_i)$ to $\bar{p}$. This expression also allows me to assume households respond to either marginal or average prices, represented by p_i. Equation (4) is used to calculate a separate flat price for CARE and non-CARE households in each climate zone in each month, allowing my analysis to incorporate a separate flat price for low-income households.[22]

If households respond to the average price, the revenue-neutral flat price is about 16 cents per kWh on average over all months for non-CARE households and 9.6 cents per kWh for CARE households. This flat price, $\bar{p}$, ranges from 8.5 cents to 22 cents based on the climate zone. The lowest Tier 1 price in the sample is 8.3 cents (a CARE price), and the highest is 44 cents depending on the month and climate region. So, on the lowest end, the flat price is only slightly higher than the cheapest electricity price and, on the highest end, the flat price is half as much as the highest price. The CARE households receive a 40 percent discount on their electricity use under the flat price relative to the higher-income households. This discount corresponds to the average discount

22. I make the same calculation under four alternative flat pricing scenarios: allowing the price to vary by region by year, by year, by region, and by month, and use those alternative flat prices to calculate the changes in electricity demand in the next section.

on electricity use for CARE households under IBPs.

I also calculate equation (4) not taking into account CARE households and calculating one flat price for all households. The average flat price without a low-income rate is 15 cents per kWh on average across all households. This allows my analysis to compare outcomes across alternative price schedules.

3.3 Do IBPs Decrease Total Electricity Use?

With the revenue-neutral flat price, $\bar{p}$, I calculate each household's counterfactual electricity use to compare total electricity use under the flat price, $D(\bar{p})$, with total electricity use under the IBP, $D(s(p_i))$. Household i's consumption under the flat price, $D_i(\bar{p})$ is given by

$$D_i(\bar{p}) = D_i(s(p_i)) + (\bar{p} - s(p_i))\delta_j \frac{D_i(s(p_i))}{s(p_i)} \tag{5}$$

where $D_i(\bar{p})$ is household consumption under the hypothetical flat price, $D(s(p_i))$ is consumption under the current block pricing regime, and p_i is household average (or marginal) price. Then, I aggregate across households within each climate zone to calculate the percentage change in total consumption under the hypothetical flat price, $D(\bar{p})$, from observed total consumption under the IBP, $D(s(p_i))$.

Figure 9 is a representative example of the steps necessary to determine the change in electricity use for a switch from flat prices to IBPs. The solid step function shows the IBP schedule in PG&E's Zone T in June 2009. The solid distribution represents actual electricity consumption under the existing IBP. The dashed line shows the flat price that would have raised the same revenue in Zone T in June 2009, calculated to be 18 cents per kWh using equation (4). The dashed distribution depicts the estimated electricity use under the counterfactual flat price of 18 cents per kWh, calculated using equation (5). The solid distribution (IBP: kWh) is a rightward shift of the dashed distribution (Flat Price: kWh), which shows that average electricity use would have increased in Zone T in June 2009 for a switch from a flat price to an IBP. I complete this exercise in every zone in every month to determine whether, in aggregate, a hypothetical switch from flat prices to IBPs decreases total electricity use.

Table 6 reports the total percentage changes in electricity demand for a change from flat prices to IBPs for each climate zone.[23] The estimates in this table are based on the point estimates for the elasticities of demand presented in Table 5. Appendix Table B.37 includes a range of estimates for the change in aggregate demand based on the 95 percent confidence intervals for the elasticity estimates. The bottom row reports the average change across climate zones for total electricity use. Total electricity consumption would have increased by 0.01 percent in 2003 and by 0.82 percent in 2009 if households responded to average electricity prices.

Total electricity consumption would have decreased by 3.43 percent in 2003 and by 4.91 percent in 2009 if households responded to marginal electricity prices.[24] Prior work suggests that households respond to average prices, meaning the results in Table 6 demonstrate that IBPs increase total electricity use relative to a flat price (Ito 2014; Wichman 2014; Shaffer 2019).

If households respond to average price, IBPs increase demand relative to a flat price. But if households respond to marginal price, IBPs decrease demand relative to a flat price. The difference in total electricity use under average versus marginal price response assumptions is due to two factors: first, I estimate smaller price sensitivities for households responding to marginal prices, and second, marginal prices are higher than average prices. So if households are responding to marginal prices, then the price signal to decrease electricity use is stronger because marginal prices are higher than average prices. These high prices lead households to cut back on their electricity consumption. Although some households still experience a decrease in price and increase their consumption, more households experience an increase in price and decrease their consumption.[25]

Table 6 shows heterogeneity in the effect of IBPs on electricity use among climate regions. This

23. Appendix Tables B.33 through B.36 report the results under alternative flat prices where the flat price varies by: region by year, region only, month only, and year only rather than by region by month. The results under these alternative flat pricing schemes are qualitatively similar to the main results. My preferred specification is by region by month as this most accurately represents the current pricing scheme–IBPs vary regionally and frequently change across months. In addition, there is redistribution that happens within a utility territory as households living further inland both tend to be lower income and pay lower electricity prices. Allowing the flat prices to vary regionally keeps this redistribution the same between the IBPs and the flat pricing schedule.

24. Appendix Table B.38 reports the same estimates using the flat price without a low income rate. These results show little change in total electricity consumption if households respond to average price and decreases in electricity use if households respond to marginal price.

25. Appendix Table B.39 shows the same changes in total electricity use under the assumption that all households have the same price elasticity of demand. These results show even larger increases in total consumption under household average price response than if there is heterogeneity in household elasticities. Similarly, the results show more conservative decreases in electricity use if households all have the same elasticity. These results demonstrate the importance of the relative elasticities of demand of households the sample. And Appendix Table B.40 shows the change in aggregate demand if households responded to last month's price. These results show slightly larger changes in total electricity consumption: bigger increases if households respond to average price and bigger decreases if households respond to marginal price than the results in Table 6.

is because there are different distributions of income, price elasticities, and electricity use among climate zones. For one extreme example of the heterogeneous demand response between climate zones, consider the difference in 2009 between PG&E's Zone T, which is PG&E's coastal zone, and SDG&E's Coastal Zone. In Zone T, households would have increased their electricity use by 1.30 percent if prices changed from flat to block, while in the Coastal Zone, households would have increased their use by only 0.30 percent. In both zones, around 30 percent of households experienced a decrease in their electricity prices with a switch from flat to block prices. But the average decrease in price in Zone T was larger (21 percent) relative to the average decrease in price in the Coastal Zone (14 percent). While the same proportion of households experienced a price decrease, because the price decrease was bigger in the PG&E region, these households increased their electricity use by relatively more than households in the Coastal Zone. The differences in total electricity use between these zones demonstrate that the effect of IBPs depends on the type of consumers served by the utility company.[26]

It is possible that IBPs are structured to change the distribution of monthly electricity use. The high marginal prices for high electricity use are designed to decrease unnecessary electricity use. In Table 7 I investigate whether the shape of the distribution of electricity use changes under IBPs versus flat prices with a CARE rate. This table shows that IBPs may slightly decrease electricity use at the 90th percentile of electricity use–in 2009, for example, the 90th percentile of electricity use was 1,111 kWh under IBPs versus 1,148 under flat prices. However, the 25th, 50th, and 75th percentiles are largely similar under IBPs and flat prices.

In Table 8 I present the median percentage change in price that households experience by income group. Assuming consumers respond to average price, I find that households with income from $0 to $49,999 experienced a 5 percent decrease in prices in 2003 and a 5.6 percent decrease in price in 2009.[27] The median household with income greater than $150,000, who use the most energy, experienced a price increase of 3.2 percent in 2003 and an increase of 7.4 percent in 2009. It is important to note that the standard deviations on the percentage change in price are quite large, implying that there are households within each income group that experience price increases and

26. Appendix Table B.41 shows aggregate changes in electricity use using the elasticity estimates by electricity use rather than by income in Appendix Table B.19. Because households in the lower two quartiles of electricity use are more price elastic than households in the upper price quartiles, these results show relatively large increases in electricity use in response to IBPs.

27. For these calculations, I am taking a separate flat price for CARE households into account.

others that experience price decreases. Section 4 further investigates the heterogeneity in changes in price by income group.

3.4 IBPs, Electricity Use, and Alternative Elasticity Estimates

To test the sensitivity of the finding that IBPs increase total electricity use, I repeat the calculations in equations (4) and (5) using two often cited papers (Reiss and White 2005; Ito 2014). Table 9 shows the changes in electricity demand using these alternate elasticities. Reiss and White (2005) find elasticity estimates ranging from -0.49 for the lowest-income households to -0.29 for the highest-income households. They estimate these elasticities using a discrete continuous choice model, assuming marginal price response. I use these estimated elasticities for δ_j and both marginal and average prices for p_i in equations (4) and (5). Under Reiss and White's elasticity estimates, changes in total electricity use range from a 1.98 percent increase for average price response to a 7.03 percent decrease for marginal price response.

The estimated change in demand is greater under Reiss and White's estimated elasticities than under my estimates for two reasons. The first is that they find that lower-income households are more price elastic than higher-income households. Since lower-income households use slightly less electricity than higher-income households, they are the most likely to experience a price decrease when switching from a flat price to an IBP. Thus, the households that experience the decrease in price are the ones that are the most price elastic. Second, they find elasticities that are larger in magnitude than my estimates, which magnifies their effects compared with my estimates.

In a more recent study of price elasticities of electricity demand, Ito (2014) estimates a price elasticity of -0.088. He does so using a simulated price instrument for households along the Southern California Edison (SCE) and SDG&E service border in San Diego. He also calculates the change in electricity use from a revenue-neutral flat price instead of IBPs. He finds that IBPs would increase aggregate demand by 0.27 percent if consumers respond to average price but would decrease aggregate demand by 2.33 percent if consumers respond to marginal price.

Table 9 shows the percentage change in total electricity use employing Ito's elasticity estimate of 0.088. Demand would have increased by 0.37 percent if households respond to average price but would have decreased 1.76 percent if households respond to marginal price. Because Ito finds that consumers are relatively price inelastic, the magnitude of the demand response is small but demonstrates that IBPs do not meet the goal of decreasing total electricity use. My results differ from Ito's because (1) I calculate a different revenue-neutral flat price in each month for CARE and non-CARE households, while he uses the long-run average electricity price, (2) my sample of households differs from his, and (3) I calculate price elasticities of demand by income group and use these in my calculations.

Table 9 summarizes these outcomes, showing that my estimates align more with the estimates using Ito's elasticities than with Reiss and White's. These differences reflect the fact that I find price elasticities that are closer in magnitude to Ito's. Ito, however, estimates only one elasticity, while both my estimates and Reiss and White's allow for heterogeneity among households with different incomes.

4 Do IBPs Help Low-Income Households?

4.1 Electricity use and Income

IBPs introduce a classic trade-off between equity and efficiency. IBPs are socially inefficient because different households pay different marginal prices for the same good (Borenstein 2012b). Rather than use IBPs, utility companies could charge marginal prices that are reflective of the social cost of electricity generation and give a cash transfer to low-income households. This type of price schedule could be preferred to IBPs because (1) all households would pay the same per-unit price and (2) cash transfers are typically more efficient than in-kind transfers (Thurow 1974). A scheme where low-income households receive a cash transfer is currently infeasible because it requires that utility companies know the income of each household they serve.[28]

Under IBPs, households' electricity bills increase as their electricity use increases. So electricity bills are higher for high-use households than for low-use households. These differences in bills between high and low users are intended to protect low-income households from high electricity bills. But whether IBPs help low-income households in practice depends on three key components. First, relief from high bills depends on the correlation between income and electricity use. Low-income households will be on the low pricing tiers only if they are low electricity users. Second,

28. The most notable exception is CARE. However, the utility company knows only that these households qualify for lower rates, not their explicit incomes.

relief from high bills depends on CARE. CARE targets household income directly, so whether IBPs help any further depends on how much help is already being provided by CARE. And third, the relief depends on the effect of utilities' climate zone pricing. Low-income households tend to live in warmer areas of California, so they live in climate zones where prices are lower, on average. I characterize the effects of these three components to determine whether IBPs protect low-income households from high electricity bills.

First, IBPs will decrease electricity bills for low-income households only if monthly electricity use is closely related to income. Figure 10 shows the distribution of electricity use by income group.[29] High-income households use more electricity than low-income households. But each distribution has a long right tail in electricity use—some households in each income group use large amounts of electricity.

The correlation between income and electricity use is 0.222 in the RASS. Differences in appliance portfolios between high- and low-income households could be one possible reason for the weak correlation between monthly electricity use and income. These differences are reported in Table 10. Low-income houses are smaller and have fewer air conditioners and televisions than high-income households. But their houses are older, have older refrigerators and heaters, and are located in warmer climates. Whether high- or low-income households use more electricity is not immediately apparent from their characteristics.

I calculate electricity use per square foot for each household to measure electricity use intensity. The higher that number, the more electricity a house uses per square foot. Electricity use intensity decreases monotonically as income increases in my sample (see Table 10). The correlation between electricity use intensity and income is -0.099. That negative relationship suggests that high-income households use less electricity per square foot than low-income households despite living in bigger homes. The negative relationship between electricity use per square foot and income further weakens the correlation between monthly electricity use and income.[30]

The above correlations between income, electricity use, and electricity use per square foot,

29. Appendix Figure B.1 shows the distribution of electricity use by income by climate zone. Note that in milder climates, such as PG&E's Zone T, the distributions of electricity use by income overlap more than in climates with warmer weather, such as Zone R.

30. I also calculate electricity use per household member. I find a negative relationship between monthly electricity use per person and income, with a correlation of -0.0031. This negative correlation suggests that each household member uses less electricity in higher-income households than lower-income households.

however, hide that in California income is correlated with weather. Wealthier households tend to live closer to the coast and experience cooler weather than poorer households. IBPs in California charge lower prices to households living farther inland because inland climate zones have higher baseline allocations of electricity use. To test whether income and electricity use are correlated *conditional* on weather, climate zone, and household appliance portfolios, I estimate the following regression via ordinary least squares:

$$ln(kWh_{it}) = \beta_0 + \beta_1 ln(\text{income}_{it}) + \beta_2 X_{it} + \tau_t + \gamma_i + \epsilon_{it} \tag{6}$$

to test the correlation between income and electricity use while controlling for other household characteristics. The income variable represents the natural log of a household's income, X_{it} represents household characteristics such as weather and appliance portfolios, τ_t represents a month-of-sample fixed effect, and γ_i represents a climate-zone fixed effect.

Appendix Table B.42 reports the results from equation (6). Columns (1) through (4) show small changes in the correlation between income and electricity use as more controls are added. Column (4) shows that conditional on regional fixed effects, weather, and household characteristics, an increase in income of 1 percent is correlated with a .093 percent increase in electricity use. The correlation decreases as I add in additional controls that are also likely correlated with income, such as regional fixed effects and household appliances. These results suggest that electricity use may not be a good proxy for income.[31]

Second, California's CARE program is designed to protect low-income households from high bills so IBPs may not offer these low-income households any additional assistance. If the lowest-income households are on CARE pricing schedules, IBPs have the potential to help only CARE-ineligible households. CARE directly targets low-income households, while IBPs use monthly electricity use as a proxy for income. Any bill protection offered by IBPs will be in addition to any protection offered by CARE.

In my sample, 16.6 percent of households meet CARE income eligibility requirements; most of these households are in the two lowest income bins. CARE prices are lower than the standard

31. Borenstein (2012b) also finds a low correlation between income and electricity use. Similarly, Cardenas and Whittington (2019) finds that higher-income households receive a larger share electricity subsidies than lower-income households in a developing country context.

IBPs and only have two tiers rather than five. Because many low-income households are already enrolled in CARE, IBPs have limited opportunities to offer assistance to low-income households.

Third, utility companies in California charge electricity prices that vary by climate zone. Electricity prices in warmer climates are lower than in cooler climates. In my sample, lower-income households tend to live in warmer areas than higher-income households, which means that they pay lower electricity prices. I take pricing by climate zone into account by estimating climate-zone-specific flat prices.

The next three sections examine the effects of IBPs on consumer welfare. First, I compare bills under three different pricing schedules, all of which raise the same revenue. Second, I calculate changes in consumer surplus from a hypothetical switch from the flat prices to the existing IBPs. And third, I calculate the deadweight loss from using prices that are higher than California's social marginal cost of electricity.

4.2 Winners and Losers from IBPs

I compare bills under three different pricing schedules that raise the same revenue: the existing IBPs with CARE, flat prices with CARE, and flat prices without CARE. Equation (4) is used to calculate the alternative flat prices, and equation (5) is used to calculate electricity use under those alternative prices. These changes in electricity bills determine whether IBPs protect low-income households from high electricity bills.

Table 11 shows median electricity bills under the existing IBPs and flat prices with CARE assuming all eligible households are enrolled in CARE. On average, the flat price for CARE households is 9.6 cents per kWh and for non-CARE households is 16 cents per kWh.[32] This calculation ensures revenue neutrality within each of the two groups (CARE and non-CARE) and reflects what a flat price might look like in California. IBPs with CARE lower electricity bills for the median low-income household from $52.39 under the flat price to $46.14 under the IBP. IBPs combined with CARE save the median household with income from $0 to $49,999 $6.25 each month. Under IBPs relative to a flat price without CARE rates, households with income from $50,000 to $74,999 pay $11.28 less each month under IBPs than flat prices, those with income from $75,000 to $149,999

32. The average prices represent those prices in a given year-month across all climate zones.

pay $9.42 less, and those with income greater than $150,000 pay $3.20 less.[33]

In terms of percentages, these changes in electricity bills represent a large share of the total bills of low-income households. IBPs, in conjunction with CARE, save these households around 12 percent on their electricity bills. The median middle- and high-income households also pay less under IBPs than they do under flat prices. Average electricity bills are higher than median electricity bills reflecting a positive skew in the distribution of electricity use. Thus, there are a few households that pay more under IBPs, but these households are the highest electricity users. IBPs save the median household across all income groups money on their electricity bills.[34]

Table 12 shows the exact same changes in electricity bills, but for a flat price without a low-income rate. The average flat price across all months and all climate zones is 15 cents per kWh. These estimates combine the effect of IBPs and CARE. IBPs with CARE lower electricity bills for the median low-income household from $62.10 under the flat price to $46.14 under the IBP. IBPs save the median household with income from $0 to $49,999 $15.96 each month. Under IBPs relative to a flat price without CARE rates, households with income from $50,000 to $74,999 pay $8.24 less each month under IBPs than flat prices, those with income from $75,000 to $149,999 pay $5.63 less, and those with income greater than $150,000 pay $0.04 less. IBPs, save the lowest-income households around 26 percent on their electricity bills. IBPs and CARE protect low-income households from high electricity bills by pushing costs onto higher-use households.

The flat monthly bills in Table 12 do not take CARE pricing into account. Thus, low-income households would be switching from a flat price without a low-income subsidy to a tiered price with a subsidy. The stark differences in bills for the lowest-income households are likely driven by the presence of CARE.

33. Appendix Table B.43 shows the same estimates under the assumption that all households have the same elasticity of demand, rather than allowing the elasticity to vary with household income. The results are very similar to those in Table 11.

34. These results are under the assumption that all households that are eligible for CARE are enrolled in the program. However, this is not likely to be the case and thus these estimates represent a "best-case scenario." It is also possible that there are some high-income households enrolled in the CARE program even though they are not eligible. CARE has relatively low audit rates leaving open the possibility that some higher income households have CARE rates.

4.3 Changes in Consumer Surplus from IBPs

IBPs charge different marginal prices to different households based on their electricity use. These differences in marginal prices distort consumption relative to a flat price where all households pay the same marginal price. The changes in consumer surplus from switching to block prices from flat prices have three components. First, per-unit electricity prices fall for the first units of electricity use. These price decreases get passed through to the consumer in the form of lower electricity bills. Second, beyond any threshold where prices are higher than the initial flat price, households pay higher per-unit prices. These higher prices are passed through to the household in the form of higher electricity bills. Whether a household's electricity bill falls for a change from flat to block prices depends on what share of its electricity use falls above or below the original flat electricity price.

Third, in addition to changing household per-unit electricity prices, IBPs also introduce deadweight loss. Relative to what they would have used under the flat price, households using electricity above the flat price underconsume, while those using electricity at lower per-unit prices overconsume.

Figure 11 represents a stylized version of the changes in consumer surplus the previous two paragraphs described. This figure shows a high-use household with a hypothetical demand curve, D. The flat price, $\bar{p}$, lies between the tiers of a hypothetical two-tier IBP such that $p_1 < \bar{p} < p_2$. Under the flat price, and given the household's demand curve, the household uses $\bar{q}_i$ kWh per month. When the pricing schedule changes to the block price from the flat price, the household now faces the second tier of the block pricing schedule, p_2. Correspondingly, electricity use falls from $\bar{q}_i$ to q_i.

There are three labeled regions in Figure 11. The first, region A, represents the increase in consumer surplus from paying a lower per-unit price, p_1, for each kWh up to the threshold where the block price increases. The second, region B, represents a decrease in consumer surplus from paying more for every kWh consumed above the threshold where the block price increases above the original flat price. The third, region C, represents the deadweight loss from underconsumption relative to the original flat price.

The example in Figure 11 demonstrates how IBPs could affect consumer surplus. Whether consumer surplus increases or decreases depends on the share of a household's consumption at prices above and below the original flat price. This example represents a two-tier IBP but also extends to IBPs with more than two tiers, as well as to low-use households.

I calculate the change in consumer surplus for all households in my sample by assuming linear demand.[35] Table 13 shows changes in consumer surplus for a switch from flat prices with CARE rates to the existing IBPs. The median lowest income household experiences a \$1.22 increase in consumer surplus, which is 2.64 percent of their electricity bills. The median highest income household experiences a \$2.02 decrease in consumer surplus, which is 1.98 percent of their electricity bill. This simple exercise demonstrates that the lowest-income households gain from IBPs and that the highest-income households lose.[36]

Table 14 shows the same the changes in consumer surplus from switching to an IBP from flat prices without a low-income rate. The median lowest-income household experiences a \$10.99 increase in consumer surplus, which is 23.82 percent of their electricity bills. The median highest-income household experiences a \$6.58 decrease in consumer surplus, which is 6.46 percent of their electricity bills.

This analysis assumes that households respond to marginal price, which is contrary to the evidence in Ito (2014) and Wichman (2014). Average price response has different implications for changes in consumer welfare because price misperception must also be taken into account. Wichman (2017) develops a model to quantify the effect of misperceiving prices on changes in consumer surplus in the context of a natural experiment.

4.4 Changes in Welfare

Electricity prices in California are higher than the social marginal cost of electricity (Borenstein and Bushnell 2018). Utility companies do not charge monthly fixed fees, so the tiered prices are structured to recover the fixed costs for the utilities. These inefficiently high prices result in households underconsuming electricity relative to the social optimum. In this section, I compare household electricity consumption under IBPs with consumption under a socially optimal flat price.

35. This assumption of linear demand is not realistic, but it illustrates the changes in consumer surplus that the households experience.

36. Appendix Table B.44 shows the same estimates under the assumption that all households have the same price elasticity of demand regardless of their income. Under this assumption, all households experience an increase in their consumer surplus under the flat price with CARE relative to an IBP with CARE.

Borenstein (2012a) calculates the socially optimal price in California, taking into account externalities from electricity generation, to be around \$0.10 per kWh. Using equation (5), I calculate each household's electricity use under this socially optimal flat price, $p_{SMC} = 0.10$. I find that, on average, households use 646 kWh per month under a flat price of 10 cents per kWh. Households use around 624 kWh per month under the revenue-neutral flat price of approximately 14 cents per kWh that I calculated if households respond to marginal price.

Given this socially optimal level of electricity use, I calculate the change in welfare associated with using the higher flat price, $\bar{p}$, that I calculated for each climate zone in each month using equation (4). This change in welfare is represented by the shaded area A in Figure 12. I complete this calculation both for marginal and average price responses.[37]

If households respond to marginal price, area A is equal to \$0.64 per household per month. If households respond to average price, area A is equal to \$1.34 per household per month. This is the deadweight loss from charging a price that is higher than the socially optimal flat price. The deadweight loss is higher under average price response because the revenue-neutral flat price must be slightly higher to recover the same revenues as the IBP.

I calculate the associated deadweight loss if the utilities move from using a socially optimal flat price to using IBPs. Again, Figure 12 represents the deadweight loss in area A + B.[38] If households respond to marginal price, area A + B is \$3.85 per household per month. If households respond to average price, area A + B is equal to \$1.56 per household per month.

Area A + B is smaller if households respond to average price for two reasons. The first is that average prices are lower than marginal prices for all tiers but the first. The distortion above the socially optimal flat price is not as large as if households are responding to marginal price. The second is that more households perceive that they experience a decrease in price if they respond to average price instead of marginal prices. This perception means that more households are optimizing with respect to a lower price than if they were responding to marginal prices. Notably, average price response means that using an IBP is actually slightly better than using a flat price. The deadweight loss is only \$1.56 rather than \$3.85 per household. This finding suggests that IBPs

37. The calculation for average price response does not take into account any misperception costs experienced by the consumer.

38. This is a stylized version of the graph for exposition and the households my sample face four- or five-tier pricing schedules.

are better for overall welfare in California than flat prices, even though they generate distortions in price.

5 Conclusion

In this paper, I have demonstrated that if households respond to average prices, California's current IBPs increase total electricity use relative to a flat price that would raise the same revenue for the utilities, which is contrary to their stated goal. This outcome depends on the relative price elasticities of households along the pricing schedule. I also find that IBPs redistribute income relative to a flat pricing schedule, but the important factor in this redistribution is the presence of CARE, the subsidized low-income electricity rate.

I find that the deadweight loss from using IBPs instead of a socially optimal flat price is smaller if households respond to average price than if they respond to marginal price. This is because electricity prices in California are higher than the social marginal cost of electricity use. IBPs charge users low prices for the first units of electricity, and these lower prices are closer to the socially optimal price.

As the United States works to confront climate change, the electricity sector is the first frontier—in 2016, this sector generated 28 percent of total greenhouse gas emissions (EPA 2016). Economists argue that electricity prices should reflect the social marginal cost of electricity generation, and IBPs are one approach to decreasing emissions while protecting households that use less electricity, who are assumed to be low-income (Borenstein 2012b; Levinson and Silva 2018). IBPs are a climate change mitigation tool used around the world. For example, China introduced IBPs for electricity in 2012 (Zhang, Cai, and Feng 2017).

It is important to understand whether IBPs meet their dual goals, because more and more utilities are considering introducing them. While IBPs are becoming increasingly common in electricity markets, nonlinear prices are pervasive. Examples of other nonlinear prices include increasing marginal tax rates and water rates and decreasing nonlinear rates for cellphone data plans. Although these pricing policies often have salutary policy goals, the results presented in this paper demonstrate that their effectiveness in meeting those goals depends on how, or whether, consumers respond to them.

For instance, increasing marginal tax rates, intended to raise revenue, may have the unintended consequence of decreasing hours worked, relative to a flat tax (Saez 2010; Kucko, Rinz, and Solow 2018; Mortenson and Whitten 2018). This is especially true if the increases in marginal tax rates are salient to consumers. Evidence shows that consumers respond better to salient prices, but it is often very difficult for households to know the price they are paying under complex nonlinear pricing schedules (Chetty, Looney, and Kroft 2009; Finkelstein 2009; Jessoe and Rapson 2014). Price salience can either help or hinder these policies in meeting their goals. More research on consumer price response is needed to evaluate the efficacy of policy outcomes where nonlinear pricing schedules are the driving mechanism.

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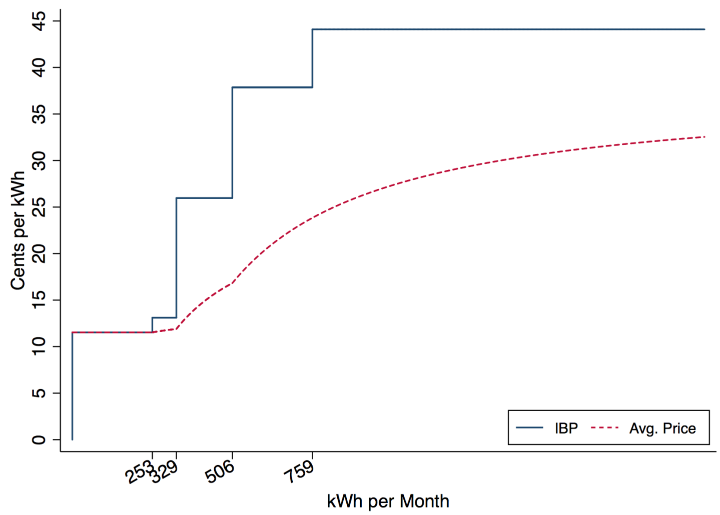
6 Figures and Tables

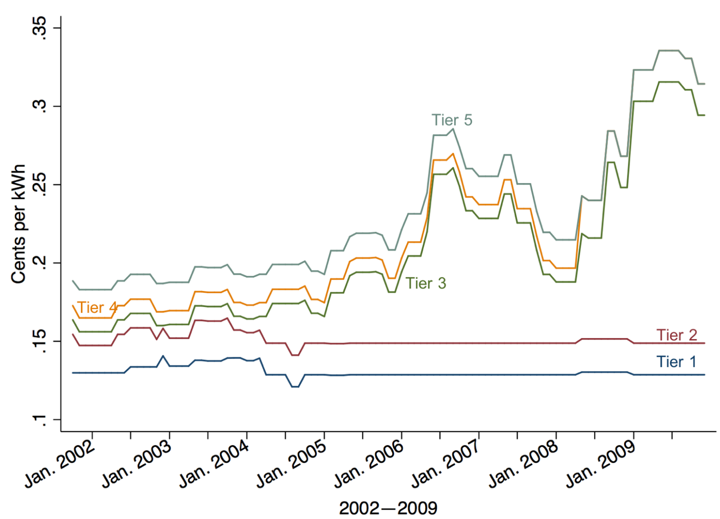
6.1 Figures

Figure 1: PG&E IBP Schedule, June 2009



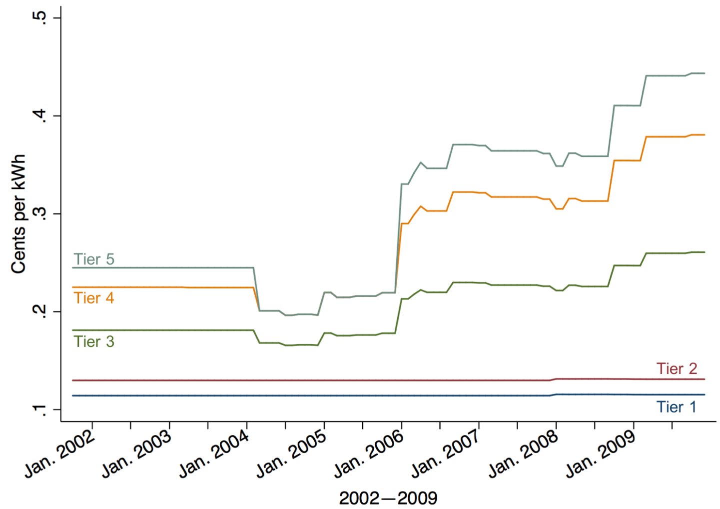
Note: This graph shows the IBP schedule for PG&E customers living in Zone T in June 2009. The solid line shows a five-tier IBP with prices ranging from 11 to 44 cents per kWh. The dashed line shows the average prices generated by the IBP schedule. Source: `https://www.pge.com/tariffs/electric.shtml` (accessed September 15, 2017).

Figure 2: SDG&E Historic Tariffs



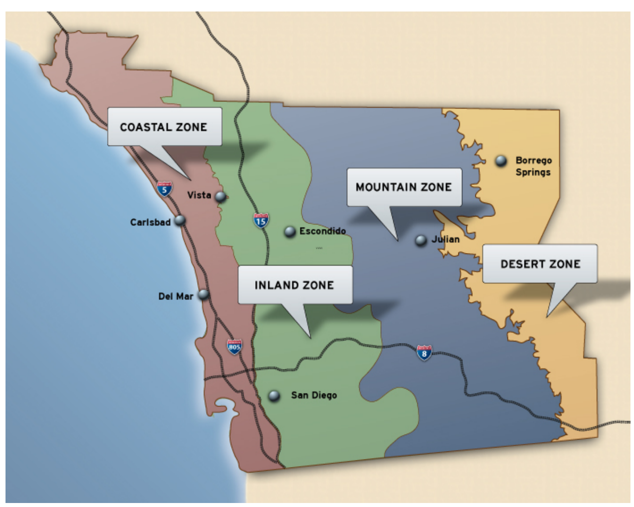
Note: This graph shows the IBP tiers over time for SDG&E customers. Tiers 1 and 2 are roughly constant over time. Tiers 3 through 5 are increasing, on average, over time. Source: I generated this graph using data from `https://www.sdge.com/rates-regulations/historical-tariffs` (accessed September 15, 2017).

Figure 3: PG&E Historic Tariffs



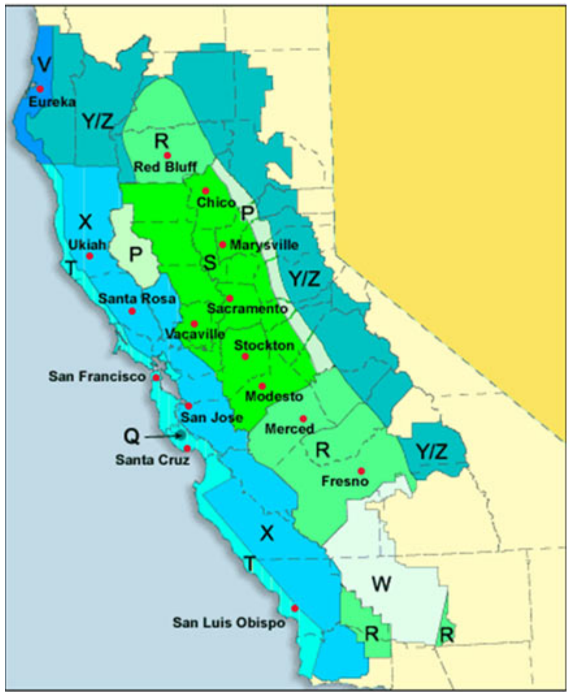
Note: This graph shows the IBP tiers over time for PG&E customers. Tiers 1 and 2 are roughly constant over time. Tiers 3 through 5 are increasing, on average, over time. Source: I generated this graph using data from `https://www.pge.com/tariffs/electric.shtml` (accessed September 15, 2017).

Figure 4: SDG&E Climate Zones



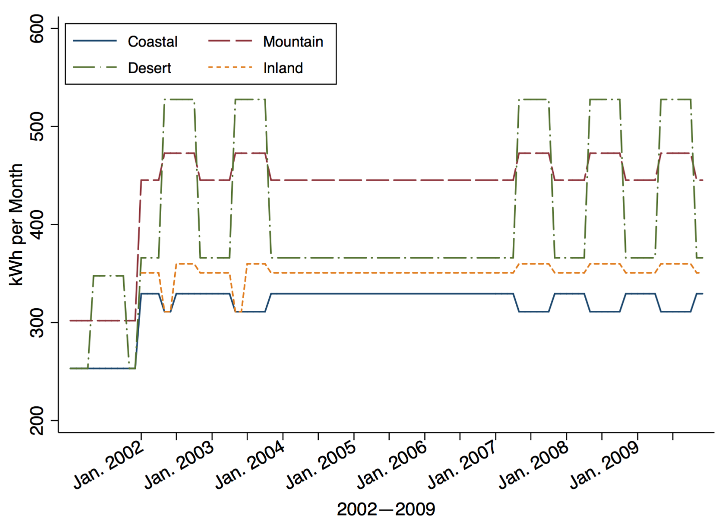
Note: This map represents the four different climate zones in SDG&E's service territory. On average, prices decrease as the zones move farther inland. Source: `https://www.sdge.com/images/3335/climate-zones-map` (accessed September 15, 2017).

Figure 5: PG&E Climate Zones



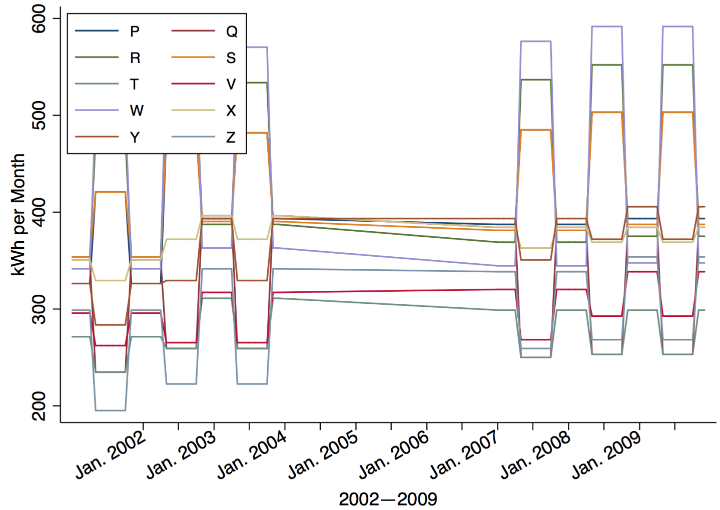
Note: This map shows the 10 different climate zones in PG&E's service territory. Source: `http://pgeandsolar.com/climate-zones-map.html` (accessed November, 1 2017).

Figure 6: SDG&E Historic Baseline Allocation by Climate Zone



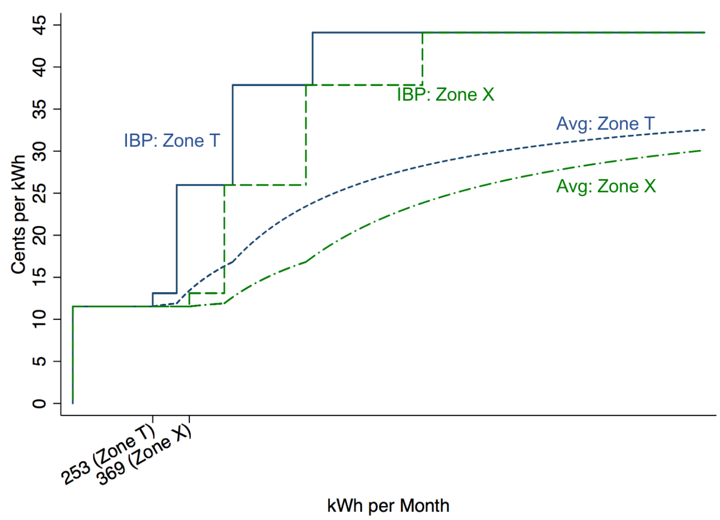
Note: This figure shows changes in baseline allocation between climate zones over time in SDG&E's service territory. Source: `https://www.sdge.com/rates-regulations/historical-tariffs` (accessed September 15, 2017).

Figure 7: PG&E Historic Baseline Allocation by Climate Zone



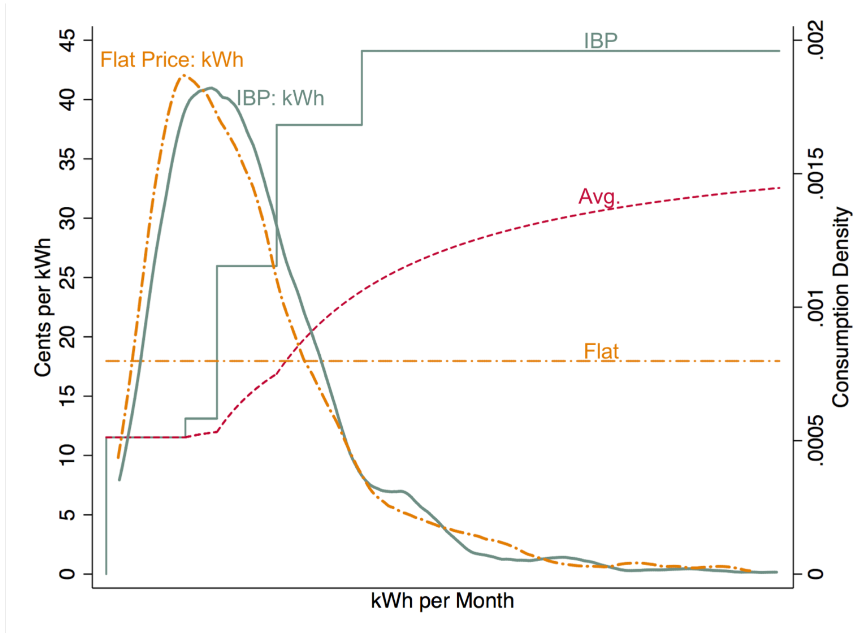
Note: This figure shows changes in baseline allocation among climate zones over time in PG&E's service territory. Source: `https://www.pge.com/tariffs/electric.shtml` (accessed September 15, 2017).

Figure 8: Prices for PG&E Climate Zones T and X in 2009



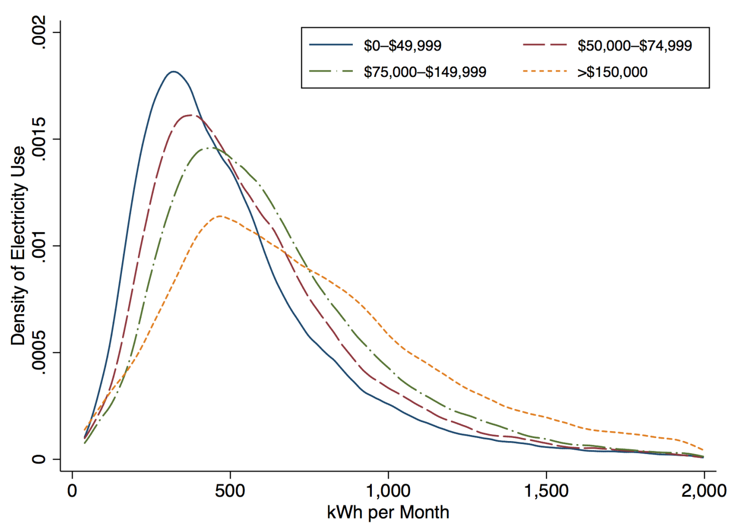
Note: This figure shows the difference in IBP schedules in two of PG&E's biggest climate zones. The solid step function is the IBP for Zone T, and the dashed step function is the IBP for Zone X. The dashed blue and green lines represent the average prices in Zone T and Zone X, respectively. Prices in Zone X are lower, on average, than in Zone T because of the bigger baseline allocation. Source: `https://www.pge.com/tariffs/electric.shtml` (accessed September 15, 2017).

Figure 9: PG&E Zone T, June 2009



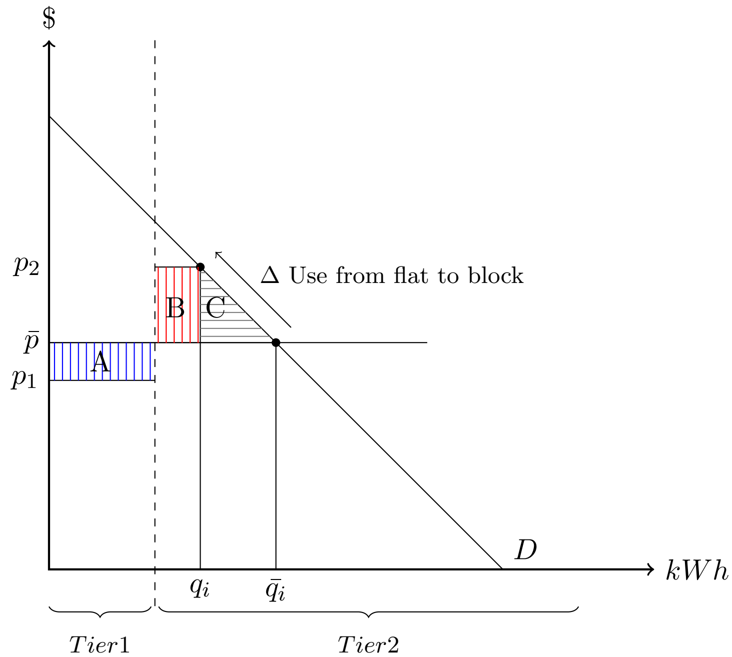
Note: This figure shows the IBP and average price households living in PG&E's Zone T paid for their electricity consumption in June 2009. The solid density represents the distribution of electricity use under that pricing schedule. The flat dashed line is the revenue-neutral price that I calculated using equation (4). The dashed distribution represents electricity use that I calculated under that flat price using equation (5). Sources: `https://www.pge.com/tariffs/electric.shtml` (accessed September 15, 2017); RASS (2009).

Figure 10: Distribution of Consumption by Income Group



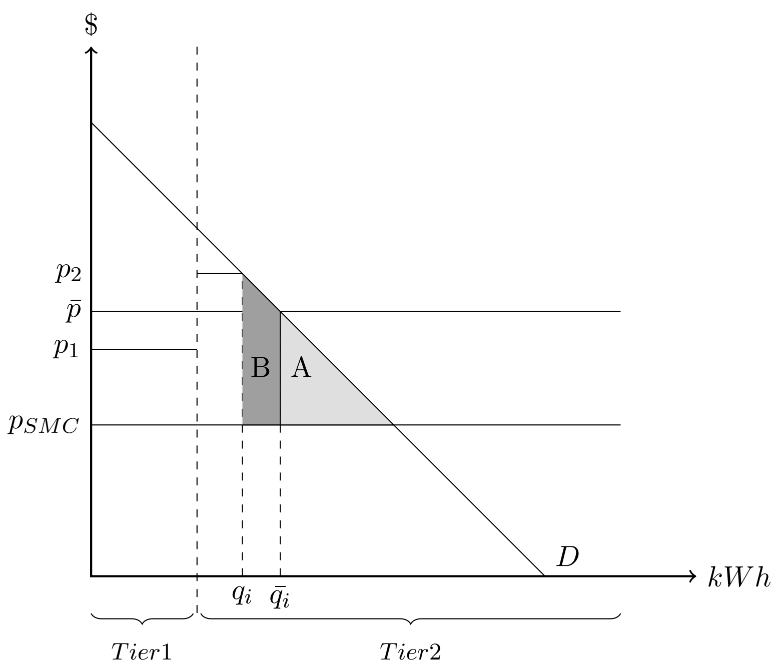
Note: This figure shows four different distributions of electricity use by income group. As income increases, the mass of the distribution shifts to the right, but all distributions are overlapping. Source: RASS (2003, 2009).

Figure 11: Welfare Change from Flat to IBP



Note: This graph represents the change in consumer surplus when switching from a flat price to an IBP schedule. This is a stylized example with a two-tier IBP.

Figure 12: Welfare Change from Social Marginal Cost to Flat to IBP



Note: This graph represents the change in welfare when switching from a socially optimal flat price of 10 cents per kWh to a flat price that raises the same revenue as the existing IBP, and then to the existing IBP. This is a stylized example with a two-tier IBP.

6.2 Tables

Table 1: Average IBP Schedule

	Price Schedules	
	2003	2009
Tier 1 ($ per kWh)	0.11	0.11
	(0.01)	(0.01)
Tier 2	0.13	0.13
	(0.02)	(0.02)
Tier 3	0.17	0.23
	(0.03)	(0.06)
Tier 4	0.20	0.29
	(0.04)	(0.09)
Tier 5	0.21	0.32
	(0.05)	(0.11)
Monthly Bill	79.52	102.82
	(61.10)	(91.94)

Note: Standard deviations in parentheses. Each column represents the average electricity prices over each year between SDG&E and PG&E. The standard deviations show that there is more variation in electricity prices for Tiers 2–5 than Tiers 1 and 2. The variation in electricity prices is also larger in 2009 than in 2003. The monthly bill represents the average electricity bill of the households in the RASS. Sources: `https://www.sdge.com/rates-regulations/historical-tariffs` and `https://www.pge.com/tariffs/electric.shtml` (accessed September 15, 2017); RASS (2003, 2009).

Table 2: RASS Summary Statistics

	RASS	
	2003	2009
kWh per Month	581.97	617.59
s.d.	338.93	357.18
Household Income (1000s in 2010$)	98.46	92.01
	65.65	60.17
# Bedrooms	3.22	3.28
	0.88	0.88
# in Household	2.79	2.73
	1.45	1.43
Year Constructed	1968.46	1970.54
	20.25	21.12
Sq Ft. (1000s)	1.85	1.91
	0.80	0.82
Household Head Graduated College	0.58	0.60
	0.49	0.49
Disabled Resident	0.09	0.11
	0.29	0.32
Own Home	0.92	0.92
	0.27	0.26
Remodeled Home	0.17	0.15
	0.37	0.36
Natural Gas Access	15.95	14.89
	34.85	33.56
House Has Electric Heat	0.05	0.02
	0.23	0.15
House Has Central Air	0.48	0.54
	0.54	0.54
# of Refrigerators	1.29	1.35
	0.50	0.54
Age of Refrigerators	7.42	7.46
	5.40	5.26
# of TVs	2.07	2.51
	0.98	1.37
# of Households	5,958	5,664

Note: Standard deviations in parentheses. Each column represents the average of the 5,958 households in the RASS in 2003 and the 5,787 households in 2009. Source: RASS (2003, 2009).

Table 3: Biased First-Difference Results

Income Group	Elasticity (Avg. Price)	Elasticity (Marg. Price)	N
Full Sample	1.648*	0.682*	36,680
	(0.0305)	(0.0164)	
\$0–\$49,999	2.136*	0.809*	10,839
	(0.0813)	(0.0359)	
\$50,000–\$74,999	1.690*	0.653*	8,000
	(0.0678)	(0.0309)	
\$75,000–\$149,999	1.559*	0.637*	12,729
	(0.0448)	(0.0249)	
>\$150,000	1.527*	0.724*	5,112
	(0.0692)	(0.0482)	

Note: Standard errors in parentheses are clustered at the household level to adjust for serial correlation in electricity consumption. Omitted covariates for the regression on average price can be seen in Table B.1 and for marginal price in Table B.2.
*$p < 0.05$

Table 4: Geographic Sample: First-Stage Results

Income Group	Avg. Price	F-Stat.	Marg. Price	# F-Stat.	# Households	# Obs.
Full Sample	0.842*		0.618*		5,373	27,144
	(0.0185)		(0.0171)			
\$0–\$49,999	0.787*		0.595*		1,542	7,801
	(0.0565)		(0.0390)			
\$50,000–\$74,999	0.830*	58.29	0.600*	76.36	1,155	5,913
	(0.0410)		(0.0379)			
\$75,000–\$149,999	0.860*	119.9	0.604*	131.0	1,909	9,695
	(0.0284)		(0.0257)			
>\$150,000	0.791*	85.27	0.645*	102.7	767	3,735
	(0.0419)		(0.0465)			

Note: Standard errors in parentheses are clustered at the household level to adjust for serial correlation in electricity consumption. This table reports the regression coefficients from the first-stage regression of the log-difference in price on the simulated instrument. The coefficients show the correlation between the simulated instrument and household's change in price over time. All regressions control for weather and a dummy for the decile of electricity consumption.
*$p < 0.05$

Table 5: Geographic Sample: Price Elasticities of Demand

Income Group	Elasticity (Avg. Price)	Elasticity (Marg. Price)	N
Full Sample	–0.163*	–0.143*	27,144
	(0.0529)	(0.0367)	
\$0–\$49,999	–0.100	–0.107	7,801
	(0.192)	(0.0879)	
\$50,000–\$74,999	–0.132	–0.0906	5,913
	(0.119)	(0.0747)	
\$75,000–\$149,999	–0.165*	–0.164*	9,695
	(0.0763)	(0.0580)	
>\$150,000	–0.427*	–0.362*	3,735
	(0.135)	(0.113)	

Note: Standard errors in parentheses are clustered at the household level to adjust for serial correlation in electricity consumption. This table reports the two-stage least squares (2SLS) results for households living within 10 km of a climate border using the simulated instrument based on kWh_{i0}. All regressions control for weather, a dummy for the decile of electricity consumption, and border fixed effects. Omitted covariates for the regression on average price can be seen in Appendix Table B.13 and for marginal price in Appendix Table B.14. Robustness checks for 5 km and 20 km can be seen in Appendix Tables B.15 and B.16, respectively.
*p $<$ 0.05

Table 6: Geographic Sample: Percentage Change in Aggregate Consumption

Percentage Change in Consumption by Year and Climate Zone	2003		2009	
PG&E	Average	Marginal	Average	Marginal
R	−0.05%	−3.05%	0.57%	−3.65%
S	0.08%	−3.27%	0.66%	−4.59%
T	0.13%	−3.75%	1.30%	−4.92%
X	0.07%	−4.11%	1.35%	−5.41%
SDG&E				
Coastal	−0.31%	−2.45%	0.25%	−5.17%
Mountain	0.09%	−1.33%	0.24%	−4.62%
Desert	0.56%	−1.26%	0.26%	−3.41%
Inland	−0.15%	−2.03%	0.40%	−4.54%
Weighted Average	0.01%	−3.43%	0.82%	−4.91%

Note: This table reports the total changes in electricity use for moving from a revenue-neutral flat price with CARE rates to the existing IBPs. Positive numbers indicate IBPs increase electricity use relative to a flat price, and negative numbers indicate that IBPs decrease electricity use. The average is weighted by the number of household-month observations in the RASS. See Appendix Table B.37 for a range of estimates using the 95% confidence interval of the point estimates from Table 5.

Table 7: Distribution of Monthly Electricity Use Under IBPs and Flat Prices

	2003		2009	
Percentile	IBP	Flat	IBP	Flat
Mean	582	582	618	613
25th Percentile	341	332	357	330
50th Percentile	503	493	543	522
75th Percentile	739	738	798	799
90th Percentile	1043	1061	1111	1148
N	101,967	101,967	87,993	87,993

Note: This table reports the change in the distribution of monthly electricity use from flat prices to IBPs. The monthly electricity use in this table assumes that households respond to average prices and that the flat rate includes a separate CARE price for low-income households. This table uses the same counterfactual flat prices as Table 6.

Table 8: Percentage Change in Price from Flat to IBP Schedule

Median Percentage Change in Price		
	Year	
Income	2003	2009
Full Sample	−6.69%	−13.25%
	12.41%	21.33%
\$0–\$49,999	−5.03%	−5.65%
	9.52%	16.05%
\$50,000–\$74,999	−10.12%	−21.82%
	12.19%	20.80%
\$75,000–\$149,999	−7.58%	−16.40%
	12.76%	22.30%
>\$150,000	−3.18%	−7.40%
	16.45%	26.18%
N	101,967	87,993

Note: Standard deviations in parentheses. This table reports the median percentage change in average electricity prices for a change from the flat price with CARE rates to an IBP weighted by the number of household-month observations in each income category in the RASS.

Table 9: Aggregate Changes Using Other Price Elasticities

	Brolinson		Reiss and White (2005)		Ito (2014)	
Year	Average	Marginal	Average	Marginal	Average	Marginal
2003	0.01%	−3.43%	1.05%	−6.27%	0.19%	−1.53%
2009	0.82%	−4.91%	3.06%	−7.91%	0.58%	−2.03%
Weighted Average	0.38%	−4.12%	1.98%	−7.03%	0.37%	−1.76%

Note: This table reports the percentage changes in average electricity use under three different sets of elasticity estimates. The averages are weighted by the number of household-month observations in the RASS. Note that Reiss and White (2005) estimate price elasticities only assuming that households respond to average price, which I apply universally under both sets of calculations. Similarly, Ito (2014) estimates price elasticities only assuming that households respond to average price.

Table 10: Descriptive Statistics by Income Group

	Income Group			
Variable Name	\$0–\$49,999	\$50,000–\$74,999	\$75,000–\$149,999	>\$150,000
kWh per Month	514.38	574.55	631.91	743.04
	315.33	326.89	337.05	410.09
kWh per Month per Sq. Ft.	0.37	0.36	0.34	0.30
	0.26	0.22	0.19	0.17
Cooling Degree Days	438.24	404.88	388.35	354.79
	665.45	608.63	567.33	503.02
Heating Degree Days	1117.64	1100.64	1078.52	1072.49
	996.82	963.20	941.98	910.21
# in Household	2.49	2.75	2.92	3.07
	1.58	1.47	1.31	1.31
Year Constructed	1965.16	1969.71	1971.82	1973.73
	20.14	19.69	20.54	22.60
Sq. Ft. (1000s)	1.55	1.74	1.98	2.64
	0.63	0.64	0.73	1.10
Household Head Graduated College	0.32	0.55	0.74	0.88
	0.47	0.50	0.44	0.33
Age of Heater	16.12	14.90	13.58	12.06
	11.46	11.06	10.45	9.47
Avg. Heating Temp.	65.09	64.80	64.45	64.88
	6.96	6.55	6.62	5.50
House Has AC	0.45	0.49	0.52	0.56
	0.50	0.50	0.50	0.50
Age of AC	11.12	10.47	10.13	9.43
	8.58	8.35	7.99	7.53
Avg. Cooling Temp.	74.81	75.49	75.64	75.30
	4.35	4.13	4.06	3.78
Refrigerator Age	7.92	7.68	7.05	6.73
	5.53	5.40	5.19	5.05
# of TVs	2.09	2.25	2.41	2.50
	1.22	1.17	1.19	1.24

Note: Standard deviations in parentheses. Each column represents the average weighted by the number of households in each income group. Source: RASS (2003, 2009).

Table 11: Changes in Electricity Bills in $ with a Flat CARE Rate

Income	Med. Bill (IBP)	Med. Bill (Flat CARE)	Change	Percentage	N
$0–$49,999	46.14	52.39	6.25	11.94%	59,831
$50,000–$74,999	64.56	75.84	11.28	14.87%	40,015
$75,000–$149,999	78.28	87.70	9.42	10.74%	63,343
>$150,000	101.83	105.03	3.20	3.05%	26,771

Note: This table presents the changes in electricity bills by income when switching from flat to block prices where the flat price includes a reduced CARE rate. A positive number for "Change" indicates that a household's electricity bills increase under a flat price. Each row is the median weighted by the number of household-month observations in that income category.

Table 12: Changes in Electricity Bills in $

Income	Med. Bill (IBP)	Med. Bill (Flat)	Change	Percentage	N
$0–$49,999	46.14	62.10	15.96	25.70%	59,831
$50,000–$74,999	64.56	72.80	8.24	11.32%	40,015
$75,000–$149,999	78.28	83.91	5.63	6.71%	63,343
>$150,000	101.83	101.87	0.04	0.04%	26,771

Note: This table presents the changes in electricity bills by income when switching from flat to block prices assuming households respond to average price. A positive number for "Change" indicates that a household's electricity bills increase under a flat price relative to the existing IBP. Each row is weighted by the number of household-month observations in that income category.

Table 13: Changes in Consumer Surplus from Flat Prices with CARE to Block by Income

Income	Med. Bill (IBP)	Med. Change in CS ($)	Percentage	N
$0–$49,999	46.14	1.22	2.64%	39,540
$50,000–$74,999	64.56	4.83	7.48%	60,446
$75,000–$149,999	78.28	3.25	4.15%	63,343
>$150,000	101.83	–2.02	–1.98%	26,771

Note: This table presents the changes in consumer surplus (CS) by income when switching from flat prices with a CARE rate to an IBP with a CARE rate. A positive number for "Change" indicates that a household's surplus increases under a flat price. Each row is weighted by the number of household-month observations in that income category.

Table 14: Changes in Consumer Surplus from Flat to Block by Income

Income	Med. Bill (IBP)	Med. Change in CS ($)	Percentage	N
$0–$49,999	46.14	10.99	23.82%	59,971
$50,000–$74,999	64.56	2.72	4.21%	40,015
$75,000–$149,999	78.28	0.93	1.18%	63,343
>$150,000	101.83	–6.58	–6.46%	26,771

Note: This table presents the changes in consumer surplus (CS) by income when switching from flat to block prices. A positive number for "Change" indicates that a household's surplus increases under a flat price. Each row is weighted by the number of household-month observations in that income category.

A Online Appendix

A.1 RASS Details

Households surveyed by the RASS were asked to participate in the study via a two-stage direct mail survey, with an option for online completion in 2009. Four months after the initial survey, the surveyors followed up with a subsample of nonrespondents via telephone and in-person interviews (KEMA 2010; Levinson 2016). Between 2003 and 2009, the RASS surveyed 46,490 households and of those, 18,231 live in the SDG&E and PG&E service territories and are included in this study. To remove outliers from the data I drop the top and bottom one percent of household-month observations for electricity use, households living in apartments, households with missing data for income and the year their home was built and renters. This leaves 11,745 households and 191,851 monthly electricity use observations in the dataset used in this study.

B Tables and Figures

Table B.1: Biased First-Difference Regression Results: Average Price

	Full Sample	\$0–\$49,999	\$50,000–\$74,999	\$75,000–\$149,999	>\$150,000
$\Delta ln(P_{it})$	1.648*	2.136*	1.690*	1.559*	1.527*
	(0.0305)	(0.0813)	(0.0678)	(0.0448)	(0.0692)
ΔHDD_{it}	−0.00000360	0.00000197	−0.00000719	−0.00000694	−0.000000980
	(0.00000288)	(0.00000465)	(0.00000665)	(0.00000442)	(0.00000948)
ΔCDD_{it}	0.0000136**	0.0000183	0.00000911	0.0000104	0.0000284*
	(0.00000482)	(0.00000948)	(0.0000107)	(0.00000772)	(0.0000116)
$1[D_{it2}]$	0.103*	0.0780*	0.0888*	0.146*	0.179*
	(0.0104)	(0.0138)	(0.0212)	(0.0255)	(0.0405)
$1[D_{it3}]$	0.142*	0.124*	0.128*	0.180*	0.191*
	(0.0107)	(0.0140)	(0.0212)	(0.0271)	(0.0389)
$1[D_{it4}]$	0.152*	0.138*	0.149*	0.183*	0.187*
	(0.0107)	(0.0147)	(0.0216)	(0.0261)	(0.0383)
$1[D_{it5}]$	0.125*	0.110*	0.121*	0.155*	0.150*
	(0.0105)	(0.0148)	(0.0213)	(0.0260)	(0.0368)
$1[D_{it6}]$	0.0943*	0.0886*	0.0855*	0.120*	0.130*
	(0.0104)	(0.0150)	(0.0216)	(0.0254)	(0.0361)
$1[D_{it7}]$	0.0727*	0.0740*	0.0470*	0.107*	0.0958**
	(0.0106)	(0.0169)	(0.0224)	(0.0255)	(0.0358)
$1[D_{it8}]$	0.0583*	0.0463**	0.0477*	0.0991*	0.0752*
	(0.0105)	(0.0165)	(0.0224)	(0.0255)	(0.0347)
$1[D_{it9}]$	0.0532*	0.0739*	0.0295	0.0898*	0.0831*
	(0.0113)	(0.0203)	(0.0256)	(0.0257)	(0.0362)
$1[D_{it10}]$	0.0544*	0.0969*	0.0408	0.0808**	0.0885*
	(0.0121)	(0.0254)	(0.0268)	(0.0274)	(0.0355)
Border F.E.	Y	Y	Y	Y	Y
N	36,680	10,839	8,000	12,729	5,112
R-sq	0.326	0.304	0.351	0.365	0.345

Note: Standard errors in parentheses are clustered at the household level to adjust for serial correlation in electricity consumption. This table presents the results for the regression on the log-difference in average price on the log-difference in electricity, including the omitted coefficients from Table 3.
*$p < 0.05$

Table B.2: Biased First-Difference Regression Results: Marginal Price

	Full Sample	\$0–\$34,999	\$35,000–\$74,999	\$75,000–\$149,999	>\$150,000
$\Delta ln(P_{it})$	0.682*	0.809*	0.653*	0.637*	0.724*
	(0.0164)	(0.0359)	(0.0309)	(0.0249)	(0.0482)
ΔHDD_{it}	−0.00000259	0.00000330	−0.00000874	−0.00000622	0.00000469
	(0.00000303)	(0.00000483)	(0.00000705)	(0.00000472)	(0.00000986)
ΔCDD_{it}	0.0000262*	0.0000274**	0.0000192	0.0000230**	0.0000492*
	(0.00000515)	(0.0000102)	(0.0000119)	(0.00000818)	(0.0000123)
$1\left[D_{it2}\right]$	0.112*	0.0882*	0.0988*	0.148*	0.193*
	(0.0101)	(0.0136)	(0.0203)	(0.0248)	(0.0386)
$1\left[D_{it3}\right]$	0.137*	0.123*	0.125*	0.168*	0.178*
	(0.0104)	(0.0136)	(0.0203)	(0.0262)	(0.0378)
$1\left[D_{it4}\right]$	0.112*	0.0944*	0.106*	0.145*	0.119**
	(0.0104)	(0.0147)	(0.0210)	(0.0251)	(0.0367)
$1\left[D_{it5}\right]$	0.0677*	0.0578*	0.0663**	0.0920*	0.0762*
	(0.0105)	(0.0154)	(0.0213)	(0.0252)	(0.0362)
$1\left[D_{it6}\right]$	0.0510*	0.0483**	0.0485*	0.0748**	0.0578
	(0.0104)	(0.0157)	(0.0217)	(0.0246)	(0.0355)
$1\left[D_{it7}\right]$	0.0729*	0.0756*	0.0548*	0.105*	0.0818*
	(0.0106)	(0.0178)	(0.0219)	(0.0247)	(0.0350)
$1\left[D_{it8}\right]$	0.0779*	0.0766*	0.0743*	0.114*	0.0762*
	(0.0104)	(0.0171)	(0.0214)	(0.0247)	(0.0345)
$1\left[D_{it9}\right]$	0.0924*	0.114*	0.0777**	0.131*	0.0958**
	(0.0112)	(0.0206)	(0.0249)	(0.0249)	(0.0360)
$1\left[D_{it10}\right]$	0.126*	0.170*	0.129*	0.149*	0.138*
	(0.0123)	(0.0260)	(0.0300)	(0.0268)	(0.0352)
Border F.E.	Y	Y	Y	Y	Y
N	36,680	10,839	8,000	12,729	5,112
R-sq	0.253	0.245	0.265	0.270	0.277

Note: Standard errors in parentheses are clustered at the household level to adjust for serial correlation in electricity consumption. This table presents the results for the regression on the log-difference in marginal price on the log-difference in electricity, including the omitted coefficients from Table 3.
*$p < 0.05$

Table B.3: Two Sided T-Test for Zone T and Zone X Before and After Trimming the Geographic Sample

Variable	(1) Mean Zone T	(2) Mean Zone X	(3) Mean Zone T (trim 10 km)	(4) Mean Zone X (trim 10 km)	(5) P-Score of T versus X (pre-trim)	(6) P-Score of T versus X (post-trim)
ln(income)	4.34	4.41	4.36	4.46	0.000	0.000
# Rooms	3.02	3.31	3.01	3.30	0.000	0.000
# in Household	2.72	2.80	2.70	2.75	0.000	0.003
Year Built	1956.97	1966.67	1956.37	1961.73	0.000	0.000
Sq Ft. (1000s)	1.76	1.96	1.75	2.01	0.000	0.000
Attended College	0.65	0.63	0.65	0.66	0.000	0.816
Disabled Family Member	0.10	0.09	0.09	0.08	0.021	0.000
# Stories	0.43	0.50	0.44	0.50	0.000	0.000
Own Residence	0.90	0.94	0.92	0.93	0.000	0.000
Exterior Wall Insulation	0.41	0.53	0.40	0.46	0.000	0.000
Ceiling Insulation	0.73	0.86	0.74	0.83	0.000	0.000
Window Type	0.37	0.43	0.37	0.43	0.000	0.000
Remodeled Home	0.18	0.18	0.18	0.19	0.236	0.023
Natural Gas Line	0.93	0.93	0.91	0.94	0.975	0.000
Electric Heat	0.04	0.02	0.04	0.01	0.000	0.000
Heater Age	16.71	14.67	16.41	15.05	0.000	0.000
AC Age	10.17	9.69	9.22	9.87	0.041	0.015
Electric Water Heater	0.04	0.04	0.05	0.03	0.033	0.000
Electric Dryer	0.40	0.52	0.42	0.50	0.000	0.000
Electric Stove	0.28	0.39	0.29	0.37	0.000	0.000
Electric Oven	0.38	0.56	0.40	0.56	0.000	0.000
# of Refrigerators	1.27	1.35	1.27	1.35	0.000	0.000
Age of Refrigerator	7.73	7.58	7.71	7.66	0.002	0.445
CDD	133.71	257.12	150.87	259.27	0.000	0.000
HDD	1353.13	1294.97	1338.25	1286.83	0.000	0.000

Note: The table above presents the means for households in Zone T and Zone X. Column (5) presents the p-score from the two-sided t-test for the difference in means of the two variables before trimming, and column (6) presents the p-score after trimming.

Table B.4: Two Sided T-Test for Zone R and Zone S Before and After Trimming the Geographic Sample

Variable	(1) Mean Zone S	(2) Mean Zone R	(3) Mean Zone S (trim 10 km)	(4) Mean Zone R (trim 10 km)	(5) P-Score of S versus R (pre-trim)	(6) P-Score of S versus R (post-trim)
ln(income)	3.90	4.41	4.11	3.59	0.791	0.000
# Rooms	3.15	3.31	3.08	2.64	0.002	0.000
# in Household	2.67	2.80	2.26	2.49	0.356	0.013
Year Built	1969.33	1966.67	1976.29	1969.54	0.003	0.000
Sq Ft. (1000s)	1.85	1.96	1.78	1.37	0.000	0.000
Attended College	0.48	0.63	0.65	0.17	0.000	0.000
Disabled Family Member	0.11	0.09	0.12	0.42	0.232	0.000
# Stories	0.75	0.50	0.75	0.49	0.000	0.000
Own Residence	0.98	0.94	1.00	0.84	0.000	0.000
Exterior Wall Insulation	0.71	0.53	0.73	0.47	0.000	0.000
Ceiling Insulation	0.89	0.86	0.93	0.94	0.030	0.466
Window Type	0.39	0.43	0.31	0.47	0.000	0.000
Remodeled Home	0.18	0.18	0.11	0.20	0.000	0.001
Natural Gas Line	0.79	0.93	0.83	0.39	0.023	0.000
Electric Heat	0.10	0.02	0.15	0.12	0.000	0.208
Heater Age	11.51	14.67	13.34	14.49	0.000	0.083
AC Age	10.93	9.69	13.16	9.11	0.022	0.000
Electric Water Heater	0.14	0.04	0.04	0.39	0.409	0.000
Electric Dryer	0.64	0.52	0.62	0.82	0.182	0.000
Electric Stove	0.46	0.39	0.41	0.72	0.000	0.000
Electric Oven	0.48	0.56	0.49	0.66	0.000	0.000
# of Refrigerators	1.43	1.35	1.37	1.22	0.000	0.000
Age of Refrigerator	8.86	7.58	9.50	5.46	0.000	0.000
CDD	685.66	257.12	694.83	760.77	0.729	0.332
HDD	1076.88	1294.97	1008.18	1180.91	0.002	0.030

Note: The table above presents the means for households in Zone R and Zone S. Column (5) presents the p-score from the two-sided t-test for the difference in means of the two variables before trimming, and column (6) presents the p-score after trimming.

Table B.5: Two Sided T-Test for Zone S and Zone X Before and After Trimming the Geographic Sample

Variable	(1) Mean Zone X	(2) Mean Zone S	(3) Mean Zone X (trim 10 km)	(4) Mean Zone S (trim 10 km)	(5) P-Score of X versus S (pre-trim)	(6) P-Score of X versus S (post-trim)
ln(income)	4.36	4.18	4.31	4.31	0.000	0.896
# Rooms	3.34	3.31	3.30	3.51	0.010	0.000
# in Household	2.67	2.84	2.61	2.97	0.000	0.000
Year Built	1972.30	1976.84	1970.61	1980.43	0.000	0.000
Sq Ft. (1000s)	1.93	1.78	1.87	1.90	0.000	0.013
Attended College	0.57	0.41	0.53	0.41	0.000	0.000
Disabled Family Member	0.10	0.13	0.10	0.11	0.000	0.060
# Stories	0.52	0.50	0.53	0.45	0.006	0.000
Own Residence	0.94	0.91	0.94	0.93	0.000	0.047
Exterior Wall Insulation	0.64	0.65	0.62	0.71	0.016	0.000
Ceiling Insulation	0.89	0.90	0.89	0.93	0.614	0.000
Window Type	0.42	0.44	0.41	0.44	0.000	0.001
Remodeled Home	0.17	0.12	0.18	0.15	0.000	0.000
Natural Gas Line	0.78	0.94	0.77	0.96	0.000	0.000
Electric Heat	0.05	0.02	0.04	0.01	0.000	0.000
Heater Age	13.83	11.91	13.87	10.91	0.000	0.000
AC Age	10.89	10.07	10.81	9.34	0.000	0.000
Electric Water Heater	0.09	0.04	0.09	0.04	0.000	0.000
Electric Dryer	0.57	0.60	0.54	0.53	0.000	0.232
Electric Stove	0.54	0.46	0.52	0.43	0.000	0.000
Electric Oven	0.68	0.52	0.66	0.53	0.000	0.000
# of Refrigerators	1.36	1.35	1.35	1.35	0.036	0.879
Age of Refrigerator	7.44	7.04	7.59	6.69	0.000	0.000
CDD	398.54	573.96	425.35	557.16	0.000	0.000
HDD	1317.92	1126.44	1335.98	1220.49	0.000	0.000

Note: The table above presents the means for households in Zone S and Zone X. Column (5) presents the p-score from the two-sided t-test for the difference in means of the two variables before trimming, and column (6) presents the p-score after trimming.

Table B.6: Two Sided T-Test for SDG&E Coastal and Inland Before and After Trimming the Geographic Sample

Variable	(1) Mean Coastal	(2) Mean Inland	(3) Mean Coastal (trim 10 km)	(4) Mean Inland (trim 10 km)	(5) P-Score of C vs. I (pre-trim)	(6) P-Score of C vs. I (post-trim)
ln(income)	4.38	4.30	4.33	4.30	0.000	0.002
# Rooms	3.40	3.40	3.37	3.41	0.530	0.001
# in Household	2.77	2.86	2.74	2.86	0.000	0.000
Year Built	1970.91	1972.49	1969.87	1972.48	0.000	0.000
Sq Ft. (1000s)	2.00	1.93	1.93	1.92	0.000	0.744
Attended College	0.69	0.61	0.67	0.61	0.000	0.000
Disabled Family Member	0.09	0.11	0.09	0.11	0.000	0.000
# Stories	0.45	0.52	0.47	0.51	0.000	0.000
Own Residence	0.92	0.94	0.92	0.94	0.000	0.000
Exterior Wall Insulation	0.50	0.50	0.49	0.50	0.752	0.024
Ceiling Insulation	0.80	0.82	0.79	0.82	0.000	0.000
Window Type	0.35	0.35	0.36	0.35	0.429	0.535
Remodeled Home	0.17	0.15	0.18	0.15	0.000	0.000
Natural Gas Line	0.98	0.97	0.98	0.97	0.000	0.000
Electric Heat	0.02	0.02	0.02	0.02	0.048	0.078
Heater Age	15.89	14.98	16.37	14.99	0.000	0.000
AC Age	9.54	10.69	10.09	10.67	0.000	0.000
Electric Water Heater	0.02	0.03	0.02	0.03	0.000	0.000
Electric Dryer	0.25	0.27	0.25	0.27	0.000	0.000
Electric Stove	0.27	0.34	0.27	0.34	0.000	0.000
Electric Oven	0.45	0.47	0.43	0.47	0.000	0.000
# of Refrigerators	1.31	1.31	1.31	1.31	0.865	0.398
Age of Refrigerator	7.28	7.49	7.29	7.48	0.000	0.001
CDD	380.73	442.35	363.32	442.14	0.000	0.000
HDD	634.51	593.04	638.08	592.18	0.000	0.000

Note: The table above presents the means for households in the SDG&E Coastal and Inland zones. Column (5) presents the p-score from the two-sided t-test for the difference in means of the two variables before trimming, and column (6) presents the p-score after trimming.

Table B.7: Two Sided T-Test for SDG&E Coastal and Mountain Before and After Trimming the Geographic Sample

Variable	(1) Mean Coastal	(2) Mean Mountain	(3) Mean Coastal (trim 10 km)	(4) Mean Mountain (trim 10 km)	(5) P-Score of C vs. M (pre-trim)	(6) P-Score of C vs. M (post-trim)
ln(income)	4.36	4.23	4.36	4.24	0.000	0.010
# Rooms	3.32	2.66	3.31	2.90	0.000	0.000
# in Household	2.77	2.75	2.77	2.66	0.768	0.249
Year Built	1973.31	1975.88	1973.17	1974.22	0.003	0.342
Sq Ft. (1000s)	1.98	1.71	1.97	1.79	0.000	0.000
Attended College	0.57	0.49	0.56	0.65	0.004	0.010
Disabled Family Member	0.10	0.14	0.10	0.14	0.026	0.086
# Stories	0.60	0.43	0.61	0.36	0.000	0.000
Own Residence	0.96	0.92	0.96	0.87	0.001	0.000
Exterior Wall Insulation	0.64	0.68	0.64	0.64	0.123	0.892
Ceiling Insulation	0.90	0.78	0.90	0.71	0.000	0.000
Window Type	0.33	0.33	0.33	0.37	0.919	0.197
Remodeled Home	0.19	0.04	0.19	0.07	0.000	0.000
Natural Gas Line	0.77	0.00	0.77	0.00	0.000	0.000
Electric Heat	0.08	0.17	0.08	0.21	0.000	0.000
Heater Age	13.77	16.33	13.66	15.13	0.000	0.039
AC Age	11.55	10.01	11.40	10.60	0.011	0.287
Electric Water Heater	0.11	0.21	0.11	0.21	0.000	0.000
Electric Dryer	0.30	0.39	0.30	0.44	0.000	0.000
Electric Stove	0.38	0.54	0.38	0.59	0.000	0.000
Electric Oven	0.49	0.57	0.49	0.65	0.003	0.000
# of Refrigerators	1.34	1.16	1.34	1.21	0.000	0.000
Age of Refrigerator	6.76	8.66	6.74	7.80	0.000	0.001
CDD	534.33	463.81	535.67	452.58	0.022	0.034
HDD	659.07	1311.59	661.09	1315.50	0.000	0.000

Note: The table above presents the means for households in the SDG&E Coastal and Mountain zones. Column (5) presents the p-score from the two-sided t-test for the difference in means of the two variables before trimming, and column (6) presents the p-score after trimming.

Table B.8: Two Sided T-Test for Zone T and Zone X Before and After Trimming the Matched Sample

Variable	(1) Mean Zone T	(2) Mean Zone X	(3) Mean Zone T (trim 10 km)	(4) Mean Zone X (trim 10 km)	(5) P-Score of T versus X (pre-trim)	(6) P-Score of T versus X (post-trim)
ln(income)	4.30	4.40	4.43	4.55	0.000	0.000
# Rooms	2.98	3.33	3.14	3.47	0.000	0.000
# in Household	2.67	2.78	2.73	2.82	0.000	0.006
Year Built	1959.54	1968.10	1975.73	1976.03	0.000	0.476
Sq. Ft. (1000s)	1.74	1.91	2.18	2.12	0.000	0.008
Attended College	0.64	0.62	0.62	0.67	0.000	0.000
Disabled Family Member	0.10	0.09	0.08	0.09	0.000	0.453
# Stories	0.43	0.53	0.40	0.49	0.000	0.000
Own Residence	0.91	0.93	0.95	0.96	0.000	0.057
Exterior Wall Insulation	0.46	0.55	0.73	0.68	0.000	0.000
Ceiling Insulation	0.75	0.86	0.86	0.92	0.000	0.000
Window Type	0.39	0.41	0.44	0.43	0.000	0.489
Remodeled Home	0.18	0.18	0.14	0.18	0.380	0.000
Natural Gas Line	0.84	0.85	0.74	0.82	0.000	0.000
Electric Heat	0.04	0.03	0.06	0.04	0.000	0.002
Heater Age	16.15	14.25	11.37	10.50	0.000	0.000
AC Age	10.28	9.96	10.16	9.90	0.065	0.168
Electric Water Heater	0.08	0.07	0.11	0.07	0.000	0.000
Electric Dryer	0.42	0.56	0.49	0.56	0.000	0.000
Electric Stove	0.31	0.47	0.37	0.44	0.000	0.000
Electric Oven	0.42	0.61	0.59	0.65	0.000	0.000
# of Refrigerators	1.26	1.34	1.33	1.41	0.000	0.000
Age of Refrigerator	7.86	7.51	8.44	7.04	0.000	0.000
Cooling Degree Days	145.79	312.84	284.33	375.50	0.000	0.000
Heating Degree Days	1462.55	1271.50	1422.70	1285.06	0.000	0.000

Note: The table above presents the means for households in Zone T and Zone X. Column (5) presents the p-score from the two-sided t-test for the difference in means of the two variables before trimming, and column (6) presents the p-score after trimming.

Table B.9: Two Sided T-Test for Zone S and Zone R Before and After Trimming the Matched Sample

Variable	(1) Mean Zone S	(2) Mean Zone R	(3) Mean Zone S (trim 10 km)	(4) Mean Zone R (trim 10 km)	(5) P-Score of S versus R (pre-trim)	(6) P-Score of S versus R (post-trim)
ln(income)	4.17	3.94	4.26	4.07	0.000	0.000
# Rooms	3.24	3.10	3.32	3.18	0.000	0.000
# in Household	2.72	2.80	2.74	2.82	0.000	0.000
Year Built	1978.11	1972.62	1982.18	1975.67	0.000	0.000
Sq. Ft. (1000s)	1.87	1.73	1.95	1.81	0.000	0.000
Attended College	0.47	0.40	0.50	0.44	0.000	0.000
Disabled Family Member	0.12	0.14	0.09	0.13	0.000	0.000
# Stories	0.57	0.64	0.56	0.66	0.000	0.000
Own Residence	0.92	0.89	0.96	0.92	0.000	0.000
Exterior Wall Insulation	0.70	0.64	0.75	0.69	0.000	0.000
Ceiling Insulation	0.90	0.88	0.94	0.91	0.000	0.000
Window Type	0.46	0.41	0.48	0.43	0.000	0.000
Remodeled Home	0.12	0.11	0.12	0.12	0.013	0.994
Natural Gas Line	0.85	0.80	0.88	0.85	0.000	0.000
Electric Heat	0.05	0.05	0.04	0.06	0.005	0.000
Heater Age	11.91	13.64	10.54	12.58	0.000	0.000
AC Age	10.01	11.10	9.93	11.19	0.000	0.000
Electric Water Heater	0.09	0.12	0.06	0.08	0.000	0.000
Electric Dryer	0.61	0.54	0.61	0.54	0.000	0.000
Electric Stove	0.45	0.50	0.45	0.51	0.000	0.000
Electric Oven	0.54	0.54	0.56	0.58	0.512	0.009
# of Refrigerators	1.35	1.29	1.35	1.32	0.000	0.000
Age of Refrigerator	7.21	7.45	7.05	7.35	0.000	0.000
Cooling Degree Days	610.99	852.09	612.09	860.70	0.000	0.000
Heating Degree Days	1147.44	1094.68	1146.98	1074.65	0.000	0.000

Note: The table above presents the means for households in Zone R and Zone S. Column (5) presents the p-score from the two-sided t-test for the difference in means of the two variables before trimming, and column (6) presents the p-score after trimming.

Table B.10: Two Sided T-Test for Zone X and Zone R Before and After Trimming the Matched Sample

Variable	(1) Mean Zone X	(2) Mean Zone S	(3) Mean Zone X (trim 10 km)	(4) Mean Zone S (trim 10 km)	(5) P-Score of X versus S (pre-trim)	(6) P-Score of X versus S (post-trim)
ln(income)	4.40	4.17	4.55	4.26	0.000	0.000
# Rooms	3.33	3.24	3.47	3.32	0.000	0.000
# in Household	2.78	2.72	2.82	2.74	0.000	0.000
Year Built	1968.10	1978.11	1976.03	1982.18	0.000	0.000
Sq. Ft. (1000s)	1.91	1.87	2.12	1.95	0.000	0.000
Attended College	0.62	0.47	0.67	0.50	0.000	0.000
Disabled Family Member	0.09	0.12	0.09	0.09	0.000	0.023
# Stories	0.53	0.57	0.49	0.56	0.000	0.000
Own Residence	0.93	0.92	0.96	0.96	0.001	0.000
Exterior Wall Insulation	0.55	0.70	0.68	0.75	0.000	0.000
Ceiling Insulation	0.86	0.90	0.92	0.94	0.000	0.000
Window Type	0.41	0.46	0.43	0.48	0.000	0.000
Remodeled Home	0.18	0.12	0.18	0.12	0.000	0.000
Natural Gas Line	0.85	0.85	0.82	0.88	0.893	0.000
Electric Heat	0.03	0.05	0.04	0.04	0.000	0.176
Heater Age	14.25	11.91	10.50	10.54	0.000	0.623
AC Age	9.96	10.01	9.90	9.93	0.557	0.705
Electric Water Heater	0.07	0.09	0.07	0.06	0.000	0.177
Electric Dryer	0.56	0.61	0.56	0.61	0.000	0.000
Electric Stove	0.47	0.45	0.44	0.45	0.000	0.103
Electric Oven	0.61	0.54	0.65	0.56	0.000	0.000
# of Refrigerators	1.34	1.35	1.41	1.35	0.191	0.000
Age of Refrigerator	7.51	7.21	7.04	7.05	0.000	0.820
Cooling Degree Days	312.84	610.99	375.50	612.09	0.000	0.000
Heating Degree Days	1271.50	1147.44	1285.06	1146.98	0.000	0.000

Note: The table above presents the means for households in Zone R and Zone S. Column (5) presents the p-score from the two-sided t-test for the difference in means of the two variables before trimming, and column (6) presents the p-score after trimming.

Table B.11: Two Sided T-Test for SDG&E Coastal and Inland Before and After Trimming the Matched Sample

Variable	(1) Mean Coastal	(2) Mean Inland	(3) Mean Coastal (trim 10 km)	(4) Mean Inland (trim 10 km)	(5) P-Score of C vs. I (pre-trim)	(6) P-Score of C vs. I (post-trim)
ln(income)	4.38	4.33	4.63	4.49	0.000	0.000
# Rooms	3.36	3.37	3.65	3.47	0.187	0.000
# in Household	2.75	2.84	2.79	2.82	0.000	0.087
Year Built	1970.62	1972.96	1981.80	1978.59	0.000	0.000
Sq Ft. (1000s)	1.99	1.95	2.37	2.14	0.000	0.000
Attended College	0.68	0.59	0.77	0.63	0.000	0.000
Disabled Family Member	0.09	0.11	0.08	0.11	0.000	0.000
# Stories	0.44	0.55	0.31	0.53	0.000	0.000
Own Residence	0.91	0.95	0.96	0.97	0.000	0.000
Exterior Wall Insulation	0.50	0.57	0.69	0.66	0.000	0.000
Ceiling Insulation	0.79	0.86	0.91	0.90	0.000	0.000
Window Type	0.35	0.34	0.34	0.33	0.168	0.141
Remodeled Home	0.18	0.17	0.18	0.16	0.001	0.000
Natural Gas Line	0.98	0.87	0.98	0.86	0.000	0.000
Electric Heat	0.02	0.05	0.01	0.06	0.000	0.000
Heater Age	15.99	14.44	11.13	11.41	0.000	0.016
AC Age	10.11	11.01	10.06	10.78	0.000	0.000
Electric Water Heater	0.02	0.07	0.01	0.06	0.000	0.000
Electric Dryer	0.24	0.29	0.23	0.28	0.000	0.000
Electric Stove	0.27	0.37	0.25	0.40	0.000	0.000
Electric Oven	0.44	0.49	0.53	0.57	0.000	0.000
# of Refrigerators	1.32	1.33	1.43	1.38	0.004	0.000
Age of Refrigerator	7.23	7.11	7.00	7.07	0.009	0.309
CDD	373.67	477.67	409.91	501.87	0.000	0.000
HDD	634.65	624.23	624.25	640.03	0.053	0.068

Note: The table above presents the means for households in the SDG&E Coastal and Inland zones. Column (5) presents the p-score from the two-sided t-test for the difference in means of the two variables before trimming, and column (6) presents the p-score after trimming.

Table B.12: Two Sided T-Test for SDG&E Coastal and Mountain Before and After Trimming the Geographic Sample

Variable	(1) Mean Coastal	(2) Mean Mountain	(3) Mean Coastal (trim 10 km)	(4) Mean Mountain (trim 10 km)	(5) P-Score of C vs. M (pre-trim)	(6) P-Score of C vs. M (post-trim)
ln(income)	4.33	4.28	4.49	4.41	0.034	0.001
# Rooms	3.37	2.90	3.47	3.10	0.000	0.000
# in Household	2.84	2.85	2.82	2.98	0.824	0.004
Year Built	1972.96	1978.39	1978.59	1986.08	0.000	0.000
Sq Ft. (1000s)	1.95	1.86	2.14	2.15	0.000	0.633
Attended College	0.59	0.62	0.63	0.65	0.051	0.212
Disabled Family Member	0.11	0.17	0.11	0.17	0.000	0.000
# Stories	0.55	0.50	0.53	0.61	0.000	0.000
Own Residence	0.95	0.96	0.97	1.00	0.008	0.000
Exterior Wall Insulation	0.57	0.73	0.66	0.75		
Ceiling Insulation	0.86	0.85	0.90	0.91	0.450	0.272
Window Type	0.34	0.33	0.33	0.34	0.432	0.645
Remodeled Home	0.17	0.09	0.16	0.06	0.000	0.000
Natural Gas Line	0.87	0.03	0.86	0.03	0.000	0.000
Electric Heat	0.05	0.10	0.06	0.14	0.000	0.000
Heater Age	14.44	15.36	11.41	11.06	0.004	0.318
AC Age	11.01	11.32	10.78	10.44	0.319	0.318
Electric Water Heater	0.07	0.28	0.06	0.19	0.000	0.000
Electric Dryer	0.29	0.42	0.28	0.31	0.000	0.214
Electric Stove	0.37	0.49	0.40	0.48	0.000	0.000
Electric Oven	0.49	0.59	0.57	0.62	0.000	0.013
# of Refrigerators	1.33	1.30	1.38	1.30	0.030	0.000
Age of Refrigerator	7.11	8.03	7.07	7.16	0.000	0.640
CDD	477.67	510.03	501.87	533.02	0.046	0.179
HDD	624.23	1163.38	640.03	997.65	0.000	0.000

Note: The table above presents the means for households in the SDG&E Coastal and Mountain zones. Column (5) presents the p-score from the two-sided t-test for the difference in means of the two variables before trimming, and column (6) presents the p-score after trimming.

Table B.13: Geographic Sample: Price Elasticities of Demand (Average Price)

	Full Sample	\$0–\$49,999	\$49,999–\$74,999	\$75,000–\$149,999	>\$150,000
$\Delta ln(P_{it})$	−0.163*	−0.100	−0.132	−0.165*	−0.427*
	(0.0529)	(0.192)	(0.119)	(0.0763)	(0.135)
ΔHDD_{it}	0.00000270	0.0000122	−0.00000293	−0.000000578	−0.000000448
	(0.00000428)	(0.00000752)	(0.00000995)	(0.00000697)	(0.0000119)
ΔCDD_{it}	0.0000370*	0.0000193	0.0000328*	0.0000410*	0.0000680*
	(0.00000671)	(0.0000132)	(0.0000138)	(0.0000110)	(0.0000186)
$1\left[D_{it2}\right]$	0.0288*	0.0101	0.0185	0.0407*	0.0968
	(0.0101)	(0.0146)	(0.0185)	(0.0195)	(0.0534)
$1\left[D_{it3}\right]$	0.00331	−0.0105	−0.00500	0.0121	0.0301
	(0.00938)	(0.0157)	(0.0189)	(0.0160)	(0.0409)
$1\left[D_{it4}\right]$	0.0168	−0.0236	−0.0112	0.0370*	0.139*
	(0.0100)	(0.0170)	(0.0203)	(0.0139)	(0.0538)
$1\left[D_{it5}\right]$	−0.00268	−0.00721	−0.00769	−0.0197	0.0543*
	(0.00934)	(0.0163)	(0.0211)	(0.0159)	(0.0247)
$1\left[D_{it6}\right]$	−0.0239*	−0.0320	−0.0578*	−0.0153	−0.00283
	(0.00970)	(0.0213)	(0.0221)	(0.0148)	(0.0231)
$1\left[D_{it7}\right]$	−0.0204*	−0.0670*	−0.0450*	−0.00602	0.0221
	(0.0100)	(0.0279)	(0.0224)	(0.0128)	(0.0240)
$1\left[D_{it8}\right]$	−0.0255*	−0.0501*	−0.0253	−0.0295*	−0.00355
	(0.00893)	(0.0203)	(0.0205)	(0.0133)	(0.0254)
$1\left[D_{it9}\right]$	−0.0461*	−0.0704*	−0.0464	−0.0428*	−0.0374
	(0.00941)	(0.0214)	(0.0245)	(0.0144)	(0.0221)
$1\left[D_{it10}\right]$	−0.105*	−0.192*	−0.107*	−0.106*	−0.0539*
	(0.0120)	(0.0386)	(0.0242)	(0.0185)	(0.0235)
Border F.E.	Y	Y	Y	Y	Y
N	27,144	7,801	5,913	9,695	3,735

Note: Standard errors in parentheses are clustered at the household level to adjust for serial correlation in electricity consumption. This table present the results from the 2SLS specification for the regression on the log-difference in electricity using the simulated instrument kWh_{i0} and reports the omitted coefficients from Table 5 for the regressions on average price.

*p <0.05

Table B.14: Geographic Sample: Price Elasticities of Demand (Marginal Price)

	Full Sample	\$0–\$49,999	\$49,999–\$74,999	\$75,000–\$149,999	>\$150,000
$\Delta ln(P_{it})$	–0.143*	–0.107	–0.0906	–0.164*	–0.362*
	(0.0367)	(0.0879)	(0.0747)	(0.0580)	(0.113)
ΔHDD_{it}	0.00000546	0.0000140	–0.000000280	0.00000339	0.00000124
	(0.00000440)	(0.00000774)	(0.0000101)	(0.00000719)	(0.0000125)
ΔCDD_{it}	0.0000355*	0.0000198	0.0000304*	0.0000399*	0.0000603*
	(0.00000697)	(0.0000133)	(0.0000151)	(0.0000116)	(0.0000190)
$1\left[D_{it2}\right]$	0.0275*	0.00943	0.0163	0.0405*	0.105
	(0.0104)	(0.0148)	(0.0190)	(0.0202)	(0.0577)
$1\left[D_{it3}\right]$	0.000944	–0.0113	–0.00866	0.0121	0.0247
	(0.00983)	(0.0161)	(0.0194)	(0.0168)	(0.0467)
$1\left[D_{it4}\right]$	0.0161	–0.0245	–0.0138	0.0402*	0.138*
	(0.0104)	(0.0175)	(0.0208)	(0.0148)	(0.0570)
$1\left[D_{it5}\right]$	–0.00277	–0.00670	–0.00979	–0.0192	0.0633*
	(0.00976)	(0.0166)	(0.0216)	(0.0166)	(0.0268)
$1\left[D_{it6}\right]$	–0.0235*	–0.0311	–0.0606*	–0.0115	–0.00359
	(0.00996)	(0.0217)	(0.0223)	(0.0151)	(0.0252)
$1\left[D_{it7}\right]$	–0.0183	–0.0655*	–0.0470*	–0.000971	0.0271
	(0.0103)	(0.0285)	(0.0226)	(0.0133)	(0.0245)
$1\left[D_{it8}\right]$	–0.0249*	–0.0487*	–0.0277	–0.0268*	–0.00697
	(0.00899)	(0.0204)	(0.0203)	(0.0135)	(0.0261)
$1\left[D_{it9}\right]$	–0.0455*	–0.0690*	–0.0492*	–0.0407*	–0.0348
	(0.00945)	(0.0211)	(0.0243)	(0.0145)	(0.0233)
$1\left[D_{it10}\right]$	–0.104*	–0.192*	–0.109*	–0.104*	–0.0533*
	(0.0120)	(0.0391)	(0.0242)	(0.0188)	(0.0234)
Border F.E.	Y	Y	Y	Y	Y
N	27,168	7,805	5,918	9,697	3,748

Note: Standard errors in parentheses are clustered at the household level to adjust for serial correlation in electricity consumption. This table present the results from the 2SLS specification for the regression on the log-difference in electricity using the simulated instrument kWh_{i0} and reports the omitted coefficients from Table 5 for the regressions on marginal price.
*p < 0.05.

Table B.15: Geographic Sample: Price Elasticities of Demand (5 km.)

Income Group	Elasticity (Avg. Price)	Elasticity (Marg. Price)	N
Full Sample	–0.140*	–0.151*	15,290
	(0.0670)	(0.0434)	
\$0–\$49,999	–0.145	–0.123	4,394
	(0.259)	(0.122)	
\$50,000–\$74,999	–0.259	–0.198*	3,367
	(0.159)	(0.101)	
\$75,000–\$149,999	–0.138	–0.181*	5,412
	(0.101)	(0.0678)	
>\$150,000	–0.205	–0.207*	2,117
	(0.131)	(0.0984)	

Note: Standard errors in parentheses are clustered at the household level to adjust for serial correlation in electricity consumption. This table reports the 2SLS results for households living within 5 km of a climate border using the simulated instrument based on kWh_{i0}. All regressions control for weather and a dummy for the decile of electricity consumption.
*$p < 0.05$

Table B.16: Geographic Sample: Price Elasticities of Demand (20 km.)

Income Group	Elasticity (Avg. Price)	Elasticity (Marg. Price)	N
Full Sample	–0.132*	–0.120*	33,314
	(0.0488)	(0.0334)	
\$0–\$49,999	0.0279	–0.0204	9,641
	(0.155)	(0.0795)	
\$50,000–\$74,999	–0.162	–0.0819	7,152
	(0.113)	(0.0686)	
\$75,000–\$149,999	–0.0959	–0.126*	11,731
	(0.0720)	(0.0524)	
>\$150,000	–0.460*	–0.362*	4,790
	(0.122)	(0.101)	

Note: Standard errors in parentheses are clustered at the household level to adjust for serial correlation in electricity consumption. This table reports the 2SLS results for households living within 20 km of a climate border using the simulated instrument based on kWh_{i0}. All regressions control for weather and a dummy for the decile of electricity consumption.
*$p < 0.05$

Table B.17: Geographic Sample: Price Elasticities of Demand Alternative Income Grouping

Income Group	Elasticity (Avg. Price)	Elasticity (Marg. Price)	N
Full Sample	–0.163*	–0.143*	27,144
	(0.0529)	(0.0367)	
\$0–\$34,999	–0.226	–0.197	5,003
	(0.292)	(0.158)	
\$35,000–\$74,999	–0.0985	–0.0766	8,711
	(0.109)	(0.0612)	
\$75,000–\$149,999	–0.165*	–0.164*	9,695
	(0.0763)	(0.0580)	
>\$150,000	–0.427*	–0.362*	3,735
	(0.135)	(0.113)	

Note: Standard errors in parentheses are clustered at the household level to adjust for serial correlation in electricity consumption. This table reports the two-stage least squares (2SLS) results for households living within 10 km of a climate border using the simulated instrument based on kWh_{i0}. All regressions control for weather, a dummy for the decile of electricity consumption, and border fixed effects.
*p $<$ 0.05

Table B.18: Geographic Sample: Heterogeneous Elasticities by Income

Income Group	Elasticity (Avg. Price)	Elasticity (Marg. Price)
\$0–\$49,999	–0.100	–0.107
	(0.192)	(0.0879)
\$50,000–\$74,999	–0.0321	0.0165
	(0.226)	(0.115)
\$75,000–\$149,999	–0.0646	–0.0569
	(0.207)	(0.105)
>\$150,000	–0.327	–0.255
	(0.234)	(0.144)
N	27,144	27,168

Note: Standard errors in parentheses are clustered at the household level to adjust for serial correlation in electricity consumption. This table reports the 2SLS results for households living within 10 km of a climate border using the simulated instrument based on kWh_{i0}. All regressions control for weather and a dummy for the decile of electricity consumption. Results reported are the marginal effects of being in a different income category. To back out the point estimate for each income group add that estimate to the base income group's estimate.
*p $<$ 0.05

Table B.19: Geographic Sample: Price Elasticities of Demand

Income Group	Elasticity (Avg. Price)	Elasticity (Marg. Price)	N
Full Sample	–0.163*	–0.143*	27,144
	(0.0529)	(0.0367)	
1st Quartile	–0.114	0.289	7,483
	(0.608)	(0.768)	
2nd Quartile	–0.548*	–0.313*	7,082
	(0.270)	(0.0895)	
3rd Quartile	–0.200*	–0.0813*	6,707
	(0.0877)	(0.0351)	
4th Quartile	–0.123*	–0.0961*	5,896
	(0.0493)	(0.0362)	

Note: Standard errors in parentheses are clustered at the household level to adjust for serial correlation in electricity consumption. This table reports the two-stage least squares (2SLS) results for households living within 10 km of a climate border using the simulated instrument based on kWh_{i0}. All regressions control for weather, a dummy for the decile of electricity consumption, and border fixed effects.
*$p < 0.05$

Table B.20: Geographic Sample: Price Elasticities of Demand

Income Group	Elasticity (Avg. Price)	*1(has AC)	Elasticity (Marg. Price)	*1(has AC)	N
Full Sample	–0.161*	–0.00279	–0.180*	0.0684	27,144
	(0.0727)	(0.0780)	(0.0478)	(0.0478)	
\$0–\$49,999	–0.0340	–0.142	–0.11	0.0259	7,801
	(0.229)	(0.329)	(0.113)	(0.141)	
\$50,000–\$74,999	–0.180	0.0796	–0.194	0.187	5,913
	(0.180)	(0.200)	(0.114)	(0.116)	
\$75,000–\$149,999	–0.158	–0.0132	–0.199*	0.0664	9,695
	(0.0964)	(0.105)	(0.0693)	(0.0694)	
>\$150,000	–0.409*	–0.0271	–0.335*	–0.0452	3,735
	(0.186)	(0.163)	(0.134)	(0.110)	

Note: Standard errors in parentheses are clustered at the household level to adjust for serial correlation in electricity consumption. This table reports the two-stage least squares (2SLS) results for households living within 10 km of a climate border using the simulated instrument based on kWh_{i0}. All regressions control for weather, a dummy for the decile of electricity consumption, and border fixed effects. This table also reports the marginal effect of owning an AC unit on the price elasticity of demand.
*$p < 0.05$

Table B.21: Geographic Sample: Price Elasticities of Demand Lagged Price

Income Group	Elasticity (Avg. Price)	Elasticity (Marg. Price)	N
Full Sample	–0.211*	–0.156*	27,168
	(0.0623)	(0.0403)	
\$0–\$49,999	–0.133	–0.113	7,805
	(0.222)	(0.0982)	
\$50,000–\$74,999	–0.168	–0.106	5,918
	(0.133)	(0.0776)	
\$75,000–\$149,999	–0.262*	–0.186*	9,697
	(0.0937)	(0.0662)	
>\$150,000	–0.424*	–0.367*	3,748
	(0.158)	(0.121)	

Note: Standard errors in parentheses are clustered at the household level to adjust for serial correlation in electricity consumption. This table reports the two-stage least squares (2SLS) results for households living within 10 km of a climate border using the simulated instrument based on kWh_{i0} and lagged prices from the previous months. All regressions control for weather, a dummy for the decile of electricity consumption, and border fixed effects.
*$p < 0.05$

Table B.22: Geographic Sample: Price Elasticities of Demand Using Simulated Instrument $\overline{kWh_i}$

Income Group	Elasticity (Avg. Price)	Elasticity (Marg. Price)	N
Full Sample	–0.0941	–0.0489	27,168
	(0.0504)	(0.0335)	
\$0–\$49,999	0.0593	0.122	7,805
	(0.155)	(0.0671)	
\$50,000–\$74,999	–0.0755	–0.0535	5,918
	(0.103)	(0.0705)	
\$75,000–\$149,999	–0.0612	–0.0465	9,697
	(0.0678)	(0.0509)	
>\$150,000	–0.353*	–0.278*	3,748
	(0.140)	(0.109)	

Note: Standard errors in parentheses are clustered at the household level to adjust for serial correlation in electricity consumption. This table reports the 2SLS results for households living within 10 km of a climate border using the simulated instrument based on $\overline{kWh_i}$. All regressions control for weather and a dummy for the decile of electricity consumption.
*$p < 0.05$

Table B.23: Geographic Sample: Price Elasticities of Demand Using Simulated Instrument kWh_{it_6}

Income Group	Elasticity (Avg. Price)	Elasticity (Marg. Price)	N
Full Sample	–0.112*	–0.103**	27,161
	(0.0563)	(0.0355)	
\$0–\$49,999	0.0456	0.0244	7,803
	(0.172)	(0.0855)	
\$50,000–\$74,999	–0.0275	–0.0452	5,917
	(0.109)	(0.0661)	
\$75,000–\$149,999	–0.0799	–0.113*	9,697
	(0.0770)	(0.0535)	
>\$150,000	–0.438**	–0.359**	3,744
	(0.163)	(0.114)	

Note: Standard errors in parentheses are clustered at the household level to adjust for serial correlation in electricity consumption. This table reports the 2SLS results for households living within 20 km of a climate border using the simulated instrument based on kWh_{it_6}. All regressions control for weather and a dummy for the decile of electricity consumption.
*p $<$ 0.05

Table B.24: Matched Sample: Price Elasticities of Demand Using kWh_{i0}

Income Group	Elasticity (Avg. Price)	Elasticity (Marg. Price)	N
Full Sample	–0.212	–0.097	106,806
\$0–\$49,999	0.034	–0.071	33,251
\$50,000–\$74,999	–0.247	–0.176	22,747
\$75,000–\$149,999	–0.246	–0.081	36,134
>\$150,000	–0.366	–0.165	14,674

Note: This table reports the 2SLS results for the matched sample between each border pair using the simulated instrument based on kWh_{i0}. All regressions control for weather and a dummy for the decile of electricity consumption. All estimates represent a weighted average across all zones.
*p $<$ 0.05

Table B.25: Matched Sample: Price Elasticities of Demand Using $\overline{kWh_i}$

Income Group	Elasticity (Avg. Price)	Elasticity (Marg. Price)	N
Full Sample	−0.281	−0.122	106,873
\$0–\$49,999	−0.212	0.030	33,268
\$50,000–\$74,999	−0.381	−0.154	22,757
\$75,000–\$149,999	−0.234	−0.126	36,154
>\$150,000	−0.384	−0.257	14,694

Note: This table reports the 2SLS results for the matched sample between each border pair using the simulated instrument based on $\overline{kWh_i}$. All regressions control for weather and a dummy for the decile of electricity consumption. All estimates represent a weighted average across all zones.
*p $<$ 0.05

Table B.26: Matched Sample: Price Elasticities of Demand Using kWh_{it_6}

Income Group	Elasticity (Avg. Price)	Elasticity (Marg. Price)	N
Full Sample	−0.300	−0.179	106,860
\$0–\$49,999	−0.095	−0.097	33,264
\$50,000–\$74,999	−0.399	−0.067	22,756
\$75,000–\$149,999	−0.245	−0.233	36,154
>\$150,000	−0.480	−0.295	14,686

Note: This table reports the 2SLS results for the matched sample between each border pair using the simulated instrument based on kWh_{it_6}. All regressions control for weather and a dummy for the decile of electricity consumption. All estimates represent a weighted average across all zones.
*p $<$ 0.05

Table B.27: Matched Sample: Price Elasticities of Demand Using kWh_{i0} Avg. Price

Climate Border	T/X	X/R	R/S	S/X	Coastal/Inland	Inland/Mountain
Full Sample	−0.130	−0.218*	−0.616*	−0.224*	−0.122*	−0.0296
	(0.0671)	(0.0804)	(0.176)	(0.0767)	(0.0613)	(0.0875)
	26,455	21,962	11,122	24,360	15,366	7,541
\$0–\$49,999	0.285	0.109	−0.384	−0.0815	0.113	0.0430
	(0.150)	(0.149)	(0.482)	(0.187)	(0.242)	(0.408)
	7,779	7,090	4,742	7,432	4,139	2,069
\$50,000–\$74,999	−0.109	−0.220	−0.719	−0.211	−0.278	−0.0810
	(0.155)	(0.196)	(0.371)	(0.200)	(0.171)	(0.206)
	5,429	4,525	2,610	5,125	3,319	1,739
\$75,000–\$149,999	−0.192	−0.292*	−0.679*	−0.236	−0.134	−0.0820
	(0.110)	(0.135)	(0.249)	(0.123)	(0.0886)	(0.117)
	9,017	7,186	3,065	8,367	5,652	2,847
>\$150,000	−0.366*	−0.394*	−0.557	−0.358*	−0.321*	−0.262
	(0.141)	(0.156)	(0.393)	(0.135)	(0.107)	(0.171)
	4,230	3,161	705	3,436	2,256	886

Note: Standard errors in parentheses are clustered at the household level to adjust for serial correlation in electricity consumption. This table reports the 2SLS results for the matched sample between each border pair using the simulated instrument based on $\overline{kWh_i}$. All regressions control for weather and a dummy for the decile of electricity consumption.

*$p < 0.05$

Table B.28: Matched Sample: Price Elasticities of Demand Using $\overline{kWh_i}$ Avg. Price

Climate Border	T/X	X/R	R/S	S/X	Coastal/Inland	Inland/Mountain
Full Sample	–0.235*	–0.252*	–0.622*	–0.340*	–0.150*	–0.105
	(0.0718)	(0.0834)	(0.169)	(0.0850)	(0.0567)	(0.0776)
	26,466	21,969	11,128	24,369	15,386	7,555
\$0–\$49,999	–0.0308	–0.0275	–1.107	–0.405	0.210	0.376
	(0.200)	(0.222)	(0.706)	(0.282)	(0.155)	(0.219)
	7,784	7,094	4,746	7,436	4,139	2,069
\$50,000–\$74,999	–0.310	–0.350	–0.611	–0.437	–0.357*	–0.222
	(0.176)	(0.228)	(0.340)	(0.237)	(0.141)	(0.176)
	5,429	4,525	2,610	5,125	3,324	1,744
\$75,000–\$149,999	–0.155	–0.163	–0.764*	–0.246*	–0.179*	–0.161
	(0.0991)	(0.111)	(0.277)	(0.113)	(0.0813)	(0.108)
	9,023	7,189	3,067	8,372	5,654	2,849
>\$150,000	–0.413*	–0.478*	–0.227	–0.419*	–0.229	–0.297
	(0.152)	(0.176)	(0.284)	(0.161)	(0.120)	(0.186)
	4,230	3,161	705	3,436	2,269	893

Note: Standard errors in parentheses are clustered at the household level to adjust for serial correlation in electricity consumption. This table reports the 2SLS results for the matched sample between each border pair using the simulated instrument based on $\overline{kWh_i}$. All regressions control for weather and a dummy for the decile of electricity consumption.

*p $<$ 0.05

Table B.29: Matched Sample: Price Elasticities of Demand Using kWh_{it_6} Avg. Price

Climate Border	T/X	X/R	R/S	S/X	Coastal/Inland	Inland/Mountain
Full Sample	−0.256*	−0.269*	−0.606*	−0.361*	−0.184*	−0.137
	(0.0816)	(0.0915)	(0.176)	(0.0944)	(0.0670)	(0.0823)
	26,466	21,969	11,128	24,369	15,379	7,549
\$0–\$49,999	0.0628	0.0341	−0.464	−0.401	0.177	0.277
	(0.200)	(0.212)	(0.468)	(0.275)	(0.179)	(0.231)
	7,784	7,094	4,746	7,436	4,137	2,067
\$50,000–\$74,999	−0.404	−0.381	−0.592	−0.395	−0.382*	−0.183
	(0.228)	(0.251)	(0.325)	(0.256)	(0.169)	(0.200)
	5,429	4,525	2,610	5,125	3,323	1,744
\$75,000–\$149,999	−0.123	−0.168	−0.909*	−0.260*	−0.189*	−0.180
	(0.109)	(0.128)	(0.322)	(0.130)	(0.0962)	(0.120)
	9,023	7,189	3,067	8,372	5,654	2,849
>\$150,000	−0.560*	−0.593*	−0.0936	−0.533*	−0.289	−0.292
	(0.182)	(0.211)	(0.330)	(0.192)	(0.148)	(0.182)
	4,230	3,161	705	3,436	2,265	889

Note: Standard errors in parentheses are clustered at the household level to adjust for serial correlation in electricity consumption. This table reports the 2SLS results for the matched sample between each border pair using the simulated instrument based on kWh_{it_6}. All regressions control for weather and a dummy for the decile of electricity consumption.

*$p < 0.05$

Table B.30: Matched Sample: Price Elasticities of Demand Using kWh_{i0} Marg. Price

Climate Border	T/X	X/R	R/S	S/X	Coastal/Inland	Inland/Mountain
Full Sample	−0.0492	−0.0493	−0.357*	−0.0612	−0.130*	−0.0711
	(0.0491)	(0.0528)	(0.143)	(0.0493)	(0.0364)	(0.0521)
	26,466	21,969	11,128	24,369	15,386	7,555
$0–$49,999	0.0742	0.0492	−0.508	−0.0390	−0.0380	−0.213
	(0.125)	(0.140)	(0.580)	(0.147)	(0.115)	(0.254)
	7,784	7,094	4,746	7,436	4,139	2,069
$50,000–$74,999	−0.103	−0.105	−0.606	−0.191	−0.119	−0.00490
	(0.105)	(0.0943)	(0.363)	(0.113)	(0.0857)	(0.102)
	5,429	4,525	2,610	5,125	3,324	1,744
$75,000–$149,999	−0.0849	−0.0600	−0.237	−0.0104	−0.129*	−0.0699
	(0.0772)	(0.0889)	(0.158)	(0.0751)	(0.0500)	(0.0683)
	9,023	7,189	3,067	8,372	5,654	2,849
>$150,000	−0.0573	−0.158	−0.296	−0.141	−0.361*	−0.195*
	(0.103)	(0.105)	(0.301)	(0.0930)	(0.0878)	(0.0992)
	4,230	3,161	705	3,436	2,269	893

Note: Standard errors in parentheses are clustered at the household level to adjust for serial correlation in electricity consumption. This table reports the 2SLS results for the matched sample between each border pair using the simulated instrument based on kWh_{i0}. All regressions control for weather and a dummy for the decile of electricity consumption.

*$p < 0.05$

Table B.31: Matched Sample: Price Elasticities of Demand Using $\overline{kWh_i}$ Marg. Price

Climate Border	T/X	X/R	R/S	S/X	Coastal/Inland	Inland/Mountain
Full Sample	−0.0377	−0.0622	−0.393*	−0.152*	−0.110**	−0.123*
	(0.0471)	(0.0515)	(0.161)	(0.0577)	(0.0370)	(0.0497)
	26,466	21,969	11,128	24,369	15,386	7,555
\$0–\$49,999	0.162	0.0945	−0.270	−0.0380	0.0913	0.126
	(0.107)	(0.138)	(0.453)	(0.152)	(0.0794)	(0.0986)
	7,784	7,094	4,746	7,436	4,139	2,069
\$50,000–\$74,999	−0.0223	−0.0536	−0.458	−0.174	−0.198*	−0.230*
	(0.117)	(0.131)	(0.276)	(0.146)	(0.0859)	(0.115)
	5,429	4,525	2,610	5,125	3,324	1,744
\$75,000–\$149,999	−0.0206	−0.0376	−0.550*	−0.156	−0.124*	−0.145
	(0.0689)	(0.0703)	(0.248)	(0.0854)	(0.0556)	(0.0798)
	9,023	7,189	3,067	8,372	5,654	2,849
>\$150,000	−0.262*	−0.319*	−0.343	−0.219*	−0.205*	−0.229
	(0.112)	(0.128)	(0.438)	(0.110)	(0.0952)	(0.126)
	4,230	3,161	705	3,436	2,269	893

Note: Standard errors in parentheses are clustered at the household level to adjust for serial correlation in electricity consumption. This table reports the 2SLS results for the matched sample between each border pair using the simulated instrument based on $\overline{kWh_i}$. All regressions control for weather and a dummy for the decile of electricity consumption.
*p < 0.05

Table B.32: Matched Sample: Price Elasticities of Demand Using kWh_{it_6} Marg. Price

Climate Border	T/X	X/R	R/S	S/X	Coastal/Inland	Inland/Mountain
Full Sample	–0.114*	–0.143*	–0.407*	–0.198*	–0.158*	–0.156*
	(0.0510)	(0.0557)	(0.119)	(0.0541)	(0.0407)	(0.0510)
	26,466	21,969	11,128	24,369	15,386	7,555
\$0–\$49,999	0.0854	–0.0278	–0.548	–0.128	0.0316	–0.138
	(0.106)	(0.121)	(0.415)	(0.129)	(0.113)	(0.152)
	7,784	7,094	4,746	7,436	4,139	2,069
\$50,000–\$74,999	–0.0382	0.0526	–0.182	–0.0246	–0.212*	–0.140
	(0.115)	(0.118)	(0.158)	(0.113)	(0.0915)	(0.109)
	5,429	4,525	2,610	5,125	3,324	1,744
\$75,000–\$149,999	–0.127	–0.241*	–0.586*	–0.278*	–0.172*	–0.158*
	(0.0800)	(0.0954)	(0.215)	(0.0899)	(0.0553)	(0.0746)
	9,023	7,189	3,067	8,372	5,654	2,849
>\$150,000	–0.376*	–0.288*	–0.0391	–0.288*	–0.272**	–0.222
	(0.125)	(0.115)	(0.206)	(0.106)	(0.105)	(0.122)
	4,230	3,161	705	3,436	2,269	893

Note: Standard errors in parentheses are clustered at the household level to adjust for serial correlation in electricity consumption. This table reports the 2SLS results for the matched sample between each border pair using the simulated instrument based on kWh_{it_6}. All regressions control for weather and a dummy for the decile of electricity consumption.
*p $<$ 0.05

Table B.33: Geographic Sample: Percentage Change in Aggregate Consumption with CARE and Non-CARE Flat Price to IBP With and Without CARE: Flat Price Varies by Region by Year

Percentage Change in Consumption by Year and Climate Zone				
	2003		2009	
PG&E	Average	Marginal	Average	Marginal
R	−0.02%	−3.03%	0.67%	−3.59%
S	0.10%	−3.25%	0.74%	−4.54%
T	0.14%	−3.74%	1.37%	−4.88%
X	0.08%	−4.10%	1.40%	−5.38%
SDG&E				
Coastal	−0.29%	−2.45%	0.34%	−5.10%
Mountain	0.10%	−1.31%	0.38%	−4.52%
Desert	0.57%	−1.23%	0.38%	−3.34%
Inland	−0.12%	−1.99%	0.51%	−4.45%
Weighted Average	0.03%	−3.42%	0.90%	−4.86%

Note: This table reports the total changes in electricity use for moving from a revenue-neutral flat price with CARE to the existing IBPs. Positive numbers indicate IBPs increase electricity use relative to a flat price, and negative numbers indicate that IBPs decrease electricity use. The average is weighted by the number of household-month observations in the RASS.

Table B.34: Geographic Sample: Percentage Change in Aggregate Consumption with CARE and Non-CARE Flat Price to IBP With and Without CARE: Flat Price Varies by Region

Percentage Change in Consumption by Year and Climate Zone				
	2003		2009	
PG&E	Average	Marginal	Average	Marginal
R	1.21%	−2.33%	−0.84%	−4.28%
S	1.58%	−2.44%	−1.08%	−5.35%
T	2.07%	−2.71%	−1.25%	−6.03%
X	2.11%	−3.04%	−1.09%	−6.41%
SDG&E				
Coastal	3.34%	−0.15%	−1.36%	−5.89%
Mountain	2.99%	0.65%	−1.13%	−5.22%
Desert	2.66%	0.05%	−0.66%	−3.95%
Inland	3.23%	0.20%	−1.07%	−5.21%
Weighted Average	2.17%	−2.21%	−1.14%	−5.77%

Note: This table reports the total changes in electricity use for moving from a revenue-neutral flat price with CARE to the existing IBPs. Positive numbers indicate IBPs increase electricity use relative to a flat price, and negative numbers indicate that IBPs decrease electricity use. The average is weighted by the number of household-month observations in the RASS.

Table B.35: Geographic Sample: Percentage Change in Aggregate Consumption with CARE and Non-CARE Flat Price to IBP With and Without CARE: Flat Price Varies by Month

Percentage Change in Consumption by Year and Climate Zone				
	2003		2009	
PG&E	Average	Marginal	Average	Marginal
R	0.17%	−2.90%	1.32%	−3.17%
S	0.43%	−3.04%	1.57%	−4.06%
T	−0.05%	−3.79%	0.99%	−4.94%
X	0.23%	−3.92%	1.86%	−4.98%
SDG&E				
Coastal	−0.90%	−3.14%	−0.32%	−5.60%
Mountain	−0.05%	−1.75%	0.32%	−4.76%
Desert	0.09%	−1.89%	0.31%	−3.56%
Inland	−0.65%	−2.65%	−0.35%	−5.12%
Weighted Average	0.00%	−3.45%	0.84%	−4.88%

Note: This table reports the total changes in electricity use for moving from a revenue-neutral flat price with CARE to the existing IBPs. Positive numbers indicate IBPs increase electricity use relative to a flat price, and negative numbers indicate that IBPs decrease electricity use. The average is weighted by the number of household-month observations in the RASS.

Table B.36: Geographic Sample: Percentage Change in Aggregate Consumption with CARE and Non-CARE Flat Price to IBP With and Without CARE: Flat Price Varies by Year

Percentage Change in Consumption by Year and Climate Zone				
	2003		2009	
PG&E	Average	Marginal	Average	Marginal
R	0.18%	−2.89%	1.49%	−3.05%
S	0.44%	−3.03%	1.79%	−3.94%
T	−0.03%	−3.78%	1.22%	−4.80%
X	0.25%	−3.90%	2.11%	−4.84%
SDG&E				
Coastal	−0.92%	−3.16%	−0.52%	−5.70%
Mountain	−0.08%	−1.77%	0.01%	−4.92%
Desert	0.02%	−1.95%	0.00%	−3.75%
Inland	−0.67%	−2.67%	−0.53%	−5.21%
Weighted Average	0.01%	−3.45%	0.92%	−4.84%

Note: This table reports the total changes in electricity use for moving from a revenue-neutral flat price with CARE to the existing IBPs. Positive numbers indicate IBPs increase electricity use relative to a flat price, and negative numbers indicate that IBPs decrease electricity use. The average is weighted by the number of household-month observations in the RASS.

Table B.37: Geographic Sample: Percentage Change in Aggregate Consumption

Percentage Change in Consumption by Year and Climate Zone								
	2003				2009			
PG&E	Average		Marginal		Average		Marginal	
	Change	[95% CI]	Change	[95% CI]	Change	[95% CI]	Change	[95% CI]
R	−0.05%	[1.11%, -0.64%]	−3.05%	[-6.52%, -0.14%]	0.57%	[3.15%, -0.70%]	−3.65%	[-7.57%, -0.22%]
S	0.08%	[1.32%, -0.58%]	−3.27%	[-6.82%, -0.29%]	0.66%	[3.95%, -0.95%]	−4.59%	[-8.77%, -0.90%]
T	0.13%	[1.43%, -0.54%]	−3.75%	[-7.59%, -0.52%]	1.30%	[6.33%, -0.87%]	−4.92%	[-9.31%, -1.09%]
X	0.07%	[1.30%, -0.58%]	−4.11%	[-8.01%, -0.83%]	1.35%	[5.81%, -0.62%]	−5.41%	[-10.09%, -1.29%]
SDG&E								
Coastal	−0.31%	[-0.2%, -0.36%]	−2.45%	[-4.93%, -0.55%]	0.25%	[2.56%, -0.88%]	−5.17%	[-9.77%, -1.21%]
Mountain	0.09%	[0.29%, -0.02%]	−1.33%	[-3.12%, 0.04%]	0.24%	[2.81%, -0.99%]	−4.62%	[-9.01%, -0.86%]
Desert	0.56%	[1.35%, 0.19%]	−1.26%	[-3.46%, 0.33%]	0.26%	[1.04%, -0.22%]	−3.41%	[-7.17%, -0.14%]
Inland	−0.15%	[0.07%, -0.27%]	−2.03%	[-4.2%, -0.34%]	0.40%	[2.72%, -0.77%]	−4.54%	[-8.8%, -0.85%]
Weighted Average	0.01%	[1.03%, -0.52%]	−3.43%	[-6.91%, -0.54%]	0.82%	[4.28%, -0.78%]	−4.91%	[-9.35%, -1.04%]

Note: This table reports the total changes in electricity use for moving from a revenue-neutral flat price with CARE rates to the existing IBPs. Positive numbers indicate IBPs increase electricity use relative to a flat price, and negative numbers indicate that IBPs decrease electricity use. The average is weighted by the number of household-month observations in the RASS. This table includes confidence intervals for the results in Table 6 based on the confidence intervals from the elasticity estimates in Table 5

Table B.38: Geographic Sample: Percentage Change in Aggregate Consumption with CARE and Non-CARE Flat Price to IBP With and Without CARE

Percentage Change in Consumption by Year and Climate Zone				
	2003		2009	
PG&E	Average	Marginal	Average	Marginal
R	−0.03%	−2.69%	0.92%	−2.57%
S	0.05%	−3.07%	0.71%	−3.94%
T	−0.05%	−3.60%	1.13%	−4.38%
X	−0.10%	−4.02%	1.03%	−5.02%
SDG&E				
Coastal	−0.50%	−2.52%	−0.12%	−5.21%
Mountain	−0.08%	−1.39%	−0.14%	−4.65%
Desert	0.14%	−1.40%	0.12%	−3.40%
Inland	−0.25%	−2.05%	0.14%	−4.53%
Weighted Average	−0.12%	−3.32%	0.61%	−4.57%

Note: This table reports the total changes in electricity use for moving from a revenue-neutral flat price with CARE to the existing IBPs. Positive numbers indicate IBPs increase electricity use relative to a flat price, and negative numbers indicate that IBPs decrease electricity use. The average is weighted by the number of household-month observations in the RASS.

Table B.39: Geographic Sample: Percentage Change in Aggregate Consumption with CARE and One Elasticity for All Income Groups

Percentage Change in Consumption by Year and Climate Zone				
	2003		2009	
PG&E	Average	Marginal	Average	Marginal
R	0.37%	−2.75%	0.81%	−3.40%
S	0.41%	−2.88%	1.17%	−3.52%
T	0.51%	−2.85%	1.64%	−3.26%
X	0.50%	−2.84%	1.44%	−3.50%
SDG&E				
Coastal	0.09%	−1.55%	0.92%	−3.30%
Mountain	0.05%	−1.33%	0.77%	−3.32%
Desert	0.06%	−1.42%	0.32%	−3.45%
Inland	0.08%	−1.54%	0.84%	−3.40%
Weighted Average	0.39%	−2.58%	1.18%	−3.40%

Note: This table reports the total changes in electricity use for moving from a revenue-neutral flat price with CARE to the existing IBPs. Positive numbers indicate IBPs increase electricity use relative to a flat price, and negative numbers indicate that IBPs decrease electricity use. The average is weighted by the number of household-month observations in the RASS. This table includes calculations assuming that all households have the same elasticity of demand, rather than allowing for differences in elasticities by income

Table B.40: Geographic Sample: Percentage Change in Aggregate Consumption with CARE and Elasticities for Lagged Prices

Percentage Change in Consumption by Year and Climate Zone				
	2003		2009	
PG&E	Average	Marginal	Average	Marginal
R	0.05%	−3.34%	0.84%	−4.04%
S	0.21%	−3.61%	1.16%	−5.01%
T	0.40%	−4.06%	2.20%	−5.26%
X	0.34%	−4.42%	2.12%	−5.78%
SDG&E				
Coastal	−0.23%	−2.63%	0.77%	−5.52%
Mountain	0.11%	−1.48%	0.50%	−4.98%
Desert	0.52%	−1.41%	0.43%	−3.82%
Inland	−0.12%	−2.22%	0.81%	−4.94%
Weighted Average	0.20%	−3.72%	1.43%	−5.29%

Note: This table reports the total changes in electricity use for moving from a revenue-neutral flat price with CARE to the existing IBPs. Positive numbers indicate IBPs increase electricity use relative to a flat price, and negative numbers indicate that IBPs decrease electricity use. The average is weighted by the number of household-month observations in the RASS. This table includes calculations separating households by income and using the lag of household prices.

Table B.41: Geographic Sample: Percentage Change in Aggregate Consumption with CARE and Elasticities by Electricity Use

Percentage Change in Consumption by Year and Climate Zone	2003		2009	
PG&E	Average	Marginal	Average	Marginal
R	1.62%	−1.95%	2.49%	−2.38%
S	2.00%	−2.02%	3.99%	−2.40%
T	2.27%	−3.57%	5.34%	−5.41%
X	2.79%	−2.29%	6.35%	−3.04%
SDG&E				
Coastal	0.76%	−1.68%	4.18%	−4.46%
Mountain	0.41%	−0.99%	3.51%	−2.36%
Desert	0.22%	−1.21%	0.94%	−3.15%
Inland	0.74%	−1.49%	4.35%	−3.46%
Weighted Average	2.05%	−2.31%	4.87%	−3.61%

Note: This table reports the total changes in electricity use for moving from a revenue-neutral flat price with CARE to the existing IBPs. Positive numbers indicate IBPs increase electricity use relative to a flat price, and negative numbers indicate that IBPs decrease electricity use. The average is weighted by the number of household-month observations in the RASS. This table includes calculations separating household elasticities for the four quartiles of electricity use, rather than by income.

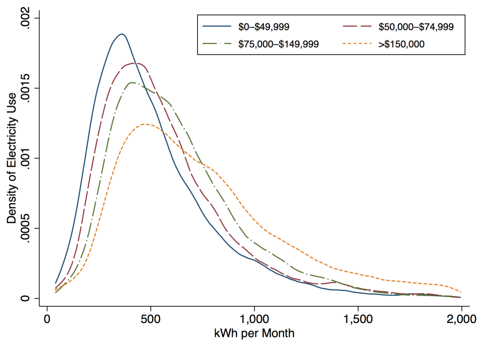
Table B.43: Changes in Electricity Bills in $ with a Flat CARE Rate and One Elasticity for all Households

Income	Med. Bill (IBP)	Med. Bill (Flat CARE)	Change	Percentage	N
$0–$49,999	46.14	51.92	5.79	11.14%	59,831
$50,000–$74,999	64.56	75.54	10.98	14.53%	40,015
$75,000–$149,999	78.28	88.03	9.76	11.08%	63,343
>$150,000	101.83	107.75	5.93	5.50%	26,771

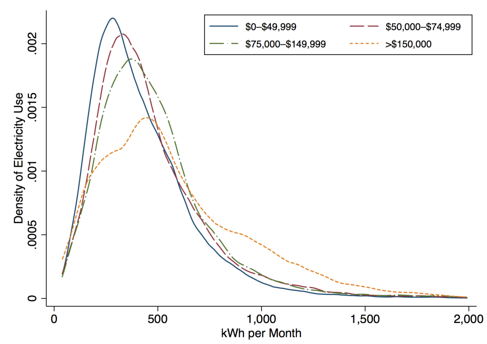
Note: This table presents the changes in electricity bills by income when switching from flat to block prices where the flat price includes a reduced CARE rate. A positive number for "Change" indicates that a household's electricity bills increase under a flat price. Each row is the median weighted by the number of household-month observations in that income category. Calculations in this table assume that all households have the same price elasticity of demand, rather than allowing the price elasticity of demand to vary by income.

Figure B.1: Electricity Use Distribution by Income by Climate Zone

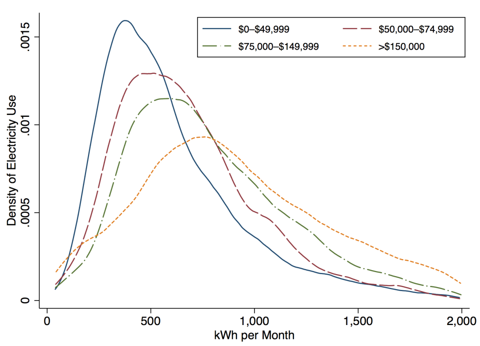
(a) PG&E Zone X



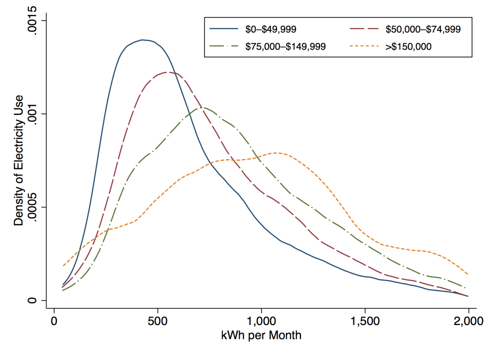
(b) PG&E Zone T



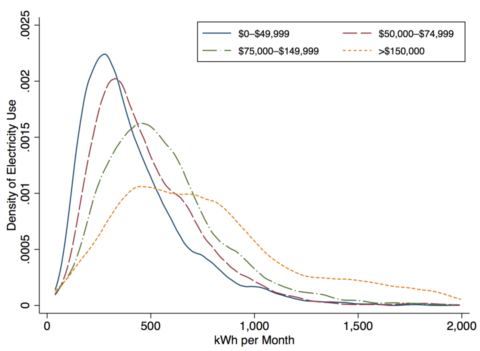
(c) PG&E Zone S



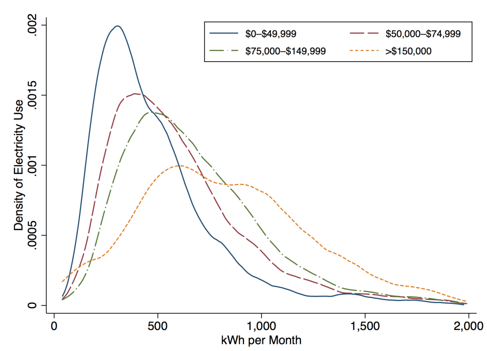
(d) PG&E Zone R



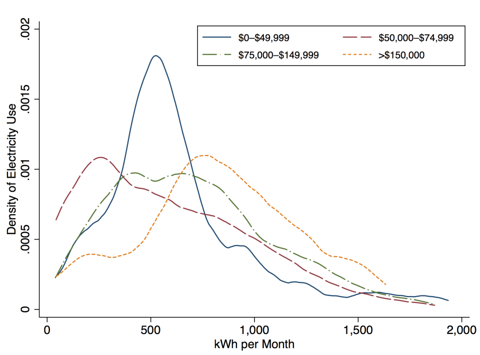
(e) SDG&E Coastal



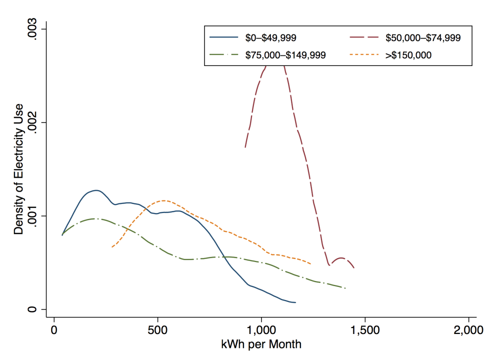
(f) SDG&E Inland



(g) SDG&E Mountain



(h) SDG&E Desert



Note: Each subfigure shows the distribution of electricity use by income for a different climate zone in PG&E's and SDG&E's service territories. Source: RASS (2003, 2009).

Table B.42: OLS: Monthly Electricity use and Income

	(1)	(2)	(3)	(4)
ln(Income)	0.171*	0.170*	0.192*	0.0933*
	(0.00177)	(0.00681)	(0.00681)	(0.00729)
Zone S			–0.0922*	–0.0185
			(0.0194)	(0.0185)
Zone T			–0.522*	–0.168*
			(0.0195)	(0.0219)
Zone X			–0.272*	–0.0522*
			(0.0171)	(0.0178)
Coastal			–0.434*	–0.190*
			(0.0202)	(0.0210)
Mountain			–0.254*	–0.0828
			(0.0843)	(0.0770)
Desert			–0.504	–0.592*
			(0.291)	(0.278)
Inland			–0.266*	–0.104*
			(0.0202)	(0.0200)
CDD				0.000245*
				(0.00000695)
HDD				0.0000249*
				(0.00000917)
# in Household				0.0669*
				(0.00358)
Year Constructed				–0.000103
				(0.000259)
Sq. Ft. (1000s)				0.147*
				(0.00857)
# Rooms				0.0204*
				(0.00712)
Attended College				–0.0538*
				(0.0100)
Age of Heater				–0.000751
				(0.000438)
Has AC				0.146*
				(0.0118)
Fridge Age				0.00519*
				(0.000844)
Fixed Effects				
Month-of-Sample	N	Y	Y	Y
Region	N	N	Y	Y
TV Count Dummy	N	N	N	Y
N	191,851	191,851	190,100	177,723
R-sq	0.046	0.055	0.121	0.291

Note: Standard errors in parentheses are clustered at the household level to adjust for serial correlation in electricity consumption. This table reports the OLS results for the regressions of electricity use on income and other controls.
*p < 0.05

Table B.44: Changes in Consumer Surplus from Flat Prices with CARE to Block by Income and One Elasticity for all Households

Income	Med. Bill (IBP)	Med. Change in CS ($)	Percentage	N
$0–$49,999	46.14	1.18	2.56%	39,540
$50,000–$74,999	64.56	5.33	8.25%	60,446
$75,000–$149,999	78.28	4.00	5.11%	63,343
>$150,000	101.83	0.53	0.53%	26,771

Note: This table presents the changes in consumer surplus (CS) by income when switching from flat prices with a CARE rate to an IBP with a CARE rate. A positive number for "Change" indicates that a household's surplus increases under a flat price. Each row is weighted by the number of household-month observations in that income category. Calculations in this table assume that all households have the same price elasticity of demand, rather than allowing the price elasticity of demand to vary by income.