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From: DNV GL - Energy
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Auto Bill Pay and Budget Billing Impact Evaluation – Residential Gas

1 INTRODUCTION

This study presents findings from DNV GL's evaluation of the relationship between automatic bill pay (ABP) and budget billing (BB), and gas consumption using PG&E's data. It is a companion piece to DNV GL's previously published evaluation of the effects on electric consumption of ABP and BB programs run by Pacific Gas and Electric (PG&E).[1] Automatic bill pay provides a convenient means of paying recurring bills through direct electronic withdrawal of funds. Budget billing, also referred to as flat, level or balanced billing, allows customers to spread their bills over a specified period through equal amount of monthly payments.

2 EVALUATION BACKGROUND

Like our earlier work, this study is motivated by a paper that found residential customers of a Southeastern utility enrolled in ABP and BB used 4% and 6.7% more electricity, respectively, than their peers.[2] The study author, Sexton, attributed such increases to the absence of a bill reminder and an attendant reduction in price salience. Sexton hypothesized that people's decisions to opt into such payment plans are not correlated with the outcome from these plans. Instead the outcomes from these programs are due to the loss of price salience. In his hypothesis, estimates of the effect of these programs are, thus, not plagued by self-selection bias. As we discussed in the full report, it is not clear that this explanation fully addresses the potential that self-selection bias could affect estimates of the effect from these programs. The main purpose of our analysis previously and now, however, was not to interrogate the validity of this argument, but to see if we could find results that are consistent with his findings when applied to California data.

Towards that purpose, in our previous study using PG&E's electricity data we found that residential customers using ABP and BB services had 1.1% to 1.6% and 3.8% to 4.7%, respectively, more energy consumption compared to those who did not. In the interest of using existing and prepared data and exploring interactive effects with another PG&E program, these findings used data from PG&E's Home Energy Report (HER) program whose study design enabled us to investigate the role such payment plans played in electricity consumption. The combined analysis also allowed us to investigate what affect HER messaging had on those who enroll in these payment plans.

[1] "Auto Bill Pay and Budget Billing Impact Evaluation – Residential," 2017, California Public Utilities Commission. www.calmac.org. CALMAC ID: CPU0163.01

[2] Automatic Bill Payment and Salience Effects: Evidence from Electricity Consumption, Steven Sexton, The Review of Economics and Statistics, May 2015, 97(2): 229-241.

The current work is an extension of this analysis to PG&E's residential gas use. The researchable questions this evaluation seeks to answer are provided in Table 1**.**

Table 1: Key research questions

	What are the pre- and post-gas consumption trends of customers who use ABP and BB?
	How do they compare to customers who do not use such payment methods?
	What are the effects of HER messaging on the consumption of those enrolled in these payment plans?

3 EVALUATION APPROACH

Sexton's study provides valuable theory and evidence to support the hypothesis that programs such as ABP and BB are associated with increases in customers' energy consumption. Using economic theory, Sexton posited that programs like ABP and BB change product or service characteristics that affect consumption choice. While programs can change service characteristics in a variety of different ways, ABP and BB alter the importance of cost or price salience of energy service; ABP makes it possible for users to meet their financial obligations for the energy service they receive without looking at their bills while BB hides the true cost of consumption by flattening the amount paid over time. Sexton hypothesized that the reduction in price salience due to inattention to the cost of energy results in consumption increases.

The "loss of price salience" argument is also essential to motivating the econometric analysis Sexton performed to produce the estimates of ABP and BB effects. It can be difficult to estimate effects of a decision where participants opt into a program. If the decision to participate is correlated with the participant's outcome, then estimates of the treatment effect may suffer from self-selection bias. In this case, because the effect is hypothesized to be due not to the choice itself but to the resulting loss of price salience, Sexton hypothesizes the correlation to be less likely. We provided a full discussion of the theoretical background and our assessment of it in the full report on ABP and BB, and electricity use published on CALMAC.[3]

Like in the electricity evaluation, we identified ABP and BB enrollment for all members of PG&E's HER treatment and control groups and combined monthly gas consumption data of all participants in a wave into a single regression analysis.[4] This is also referred to as a "time-series cross-sectional analysis" because observations vary both across time and across individual dwellings. We then used a fixed-effects regression model to measure the association between ABP and BB enrollment and gas use, and the effect of ABP and BB conditional on Opower's HER participation. Using a fixed-effects approach allows for the measurement of ABP and BB and HER-related impacts while also controlling for other possible confounding factors. However, there is still a possibility of self-selection bias that could affect the results.

[3] "Auto Bill Pay and Budget Billing Impact Evaluation – Residential," 2017, California Public Utilities Commission. www.calmac.org. CALMAC ID: CPU0163.01

[4] ABP and BB enrollment data was merged to HER program and billing data for the analyses.

The fixed-effects model we estimate is given by:

$$C_{jt} = \mu_j + \lambda_t + \gamma_A ABP_{jt} + \gamma_B BB_{jt} + \gamma_H HER_{jt} + \gamma_{AH} ABP_{jt} * HER_{jt} + \gamma_{BH} BB_{jt} * HER_{jt} + \varepsilon_{jt}$$

- Cjt = the log of average daily consumption during interval t for household j
- μ_j = unique intercept for each household j
- λt = 0/1 indicator for each time interval t (month-year) that tracks systematic change over time
- $HERjt$ = 0/1 dummy variable equal to 1 if household j is in the HER treatment group in period t, 0 if household j is in the comparison group in period t
- $ABPjt$ = 0/1 dummy variable equal to 1 if household j is an ABP enrollee in period t, 0 otherwise
- $BBjt$ = 0/1 dummy variable equal to 1 if household j is an BB enrollee in period t, 0 otherwise
- ε_{jt} = error term or random noise of the model

4 DATA

In 2015, 12% of PG&E's residential gas customers were enrolled in auto-pay while 5.1% were enrolled in budget billing (Table 2). A subset (0.9%) of customers were enrolled in both ABP and BB. Given that the two programs are different, it is not a surprise that the overlap in enrollment is not greater. Since most customers are dual fuel, these percentages are the same as those we reported for residential electric customers.

Table 2: 2015 ABP, BB, and total gas customer counts

	Number	Percent of total
All ABP*	514,257	12.0%
All BB*	216,756	5.1%
ABP/BB overlap	40,250	0.9%
Total gas customers	4,276,330	

**Includes 40,250 ABP/BB overlap enrollees*

Like the electricity study, we focused our gas study on PG&E's HER wave 3 and wave 4 rollouts.[5] We estimated the fixed-effects model for each wave separately to identify the effect of enrollment in the two payment plans on consumption as well as the additional effect of HER treatment for households enrolled in these payment programs. HER wave 3 began in July 2013 and involved 225,000 and 75,000 randomly assigned treatment and control households respectively. PG&E's fourth HER wave started in March 2014 and involved 200,000 and 75,000 randomly assigned treatment and control households respectively.

We present a summary of ABP and BB enrollment for each wave in Table 3. In PG&E's HER data sets that we used in this study, the percent of ABP and BB enrollment is somewhat different than those in the general population (Table 2). While 12% of total gas customers enrolled in ABP, in the HER data about 9% to 10%

5 We focus on more than one HER wave to ascertain that our findings are stable across waves and not a function of a specific dataset. These specific HER waves were chosen from a set of 6 possible waves as they represent the widest possible coverage (territory and consumption level) and included a higher number of customers on both ABP and BB relative to other HER waves. We presented a table on the features of the HER programs used in the study in the full report that detailed our work on ABP and BB, and electricity use in PG&E's service territory. The important things to note about the HER waves we used in our analyses is that both waves targeted the highest 3 usage quartiles where those in the treatment group received standard frequency reports, and involved dual or single-fuel households, in the third wave, and dual fuel households in the fourth wave.

of customers were enrolled in ABP. On the other hand, BB enrollment is 5% at the total customer population level while about 6% to 8% of the HER population is enrolled in BB. Such differences probably reflect the fact that HER sampling focuses on a specific and not a random subset of the total population; for instance, we know these two waves target single family households whose consumption is in the top three-quartiles.

Table 3: ABP and BB enrollment in the study data sets

Group	Full Population	ABP		BB	
Wave 3 Treatment and Control	231,379	21,283	9.2%	18,479	8.0%
Wave 3 Treatment	173,662	15,935	9.2%	13,841	8.0%
Wave 4 Treatment and Control	224,085	21,506	9.6%	13,686	6.1%
Wave 4 Treatment	163,003	15,652	9.6%	9,942	6.1%

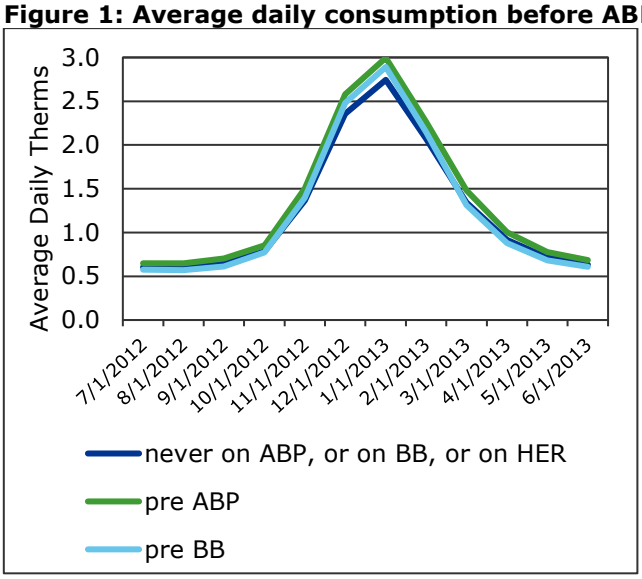
ABP and BB enrollment levels in our gas study are similar to such enrollments in our electricity study. In addition, like what we saw for electricity, between 79% and 89% of ABP and BB participants signed on prior to the timeframe covered by this analysis (Table 4). In the regression context, the effects of enrollment for these earlier enrollees cannot be estimated. Thus, the estimated ABP and BB coefficients reflect the association of these plans with consumption for households that enrolled in these plans during the study periods. The table also provides average and maximum daily gas consumption values.

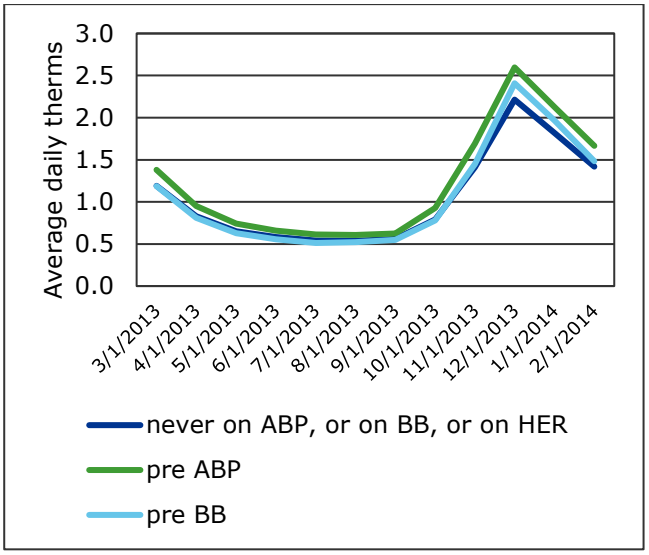
Table 4: Summary statistics of data used in the study

	Wave Three	Wave Four
Percent ABP enrollment before data start	85%	89%
Percent BB enrollment before data start	80%	79%
Mean daily Therms	1.08	0.93
Maximum daily Therms	39.61	49.42

While summary statistics of consumption levels are useful, we also examined seasonal variation and differences in gas use among households that eventually enroll in ABP and BB and those that never do. Figure 1 presents monthly gas use prior to enrollment in ABP and BB for both the wave 3 and 4 HER cohorts and for those who never enroll in either during the pre-HER treatment period; thus, gas use we present in the plots were unaffected by any of the programs under consideration in this study.

Figure 1: Average daily consumption before ABP and BB enrollment – waves 3 and 4

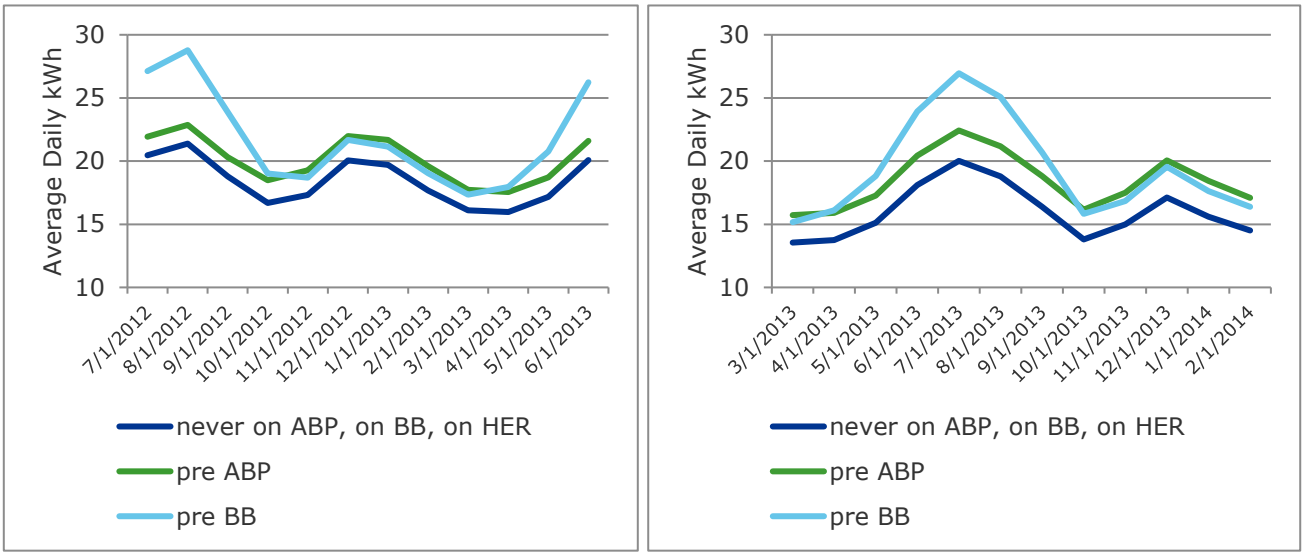




The baseload gas consumption for future BB enrollees is at or below the level of non-enrollees during the summer. During the winter, the consumption of future BB enrollees is approximately 7% higher than that of non-enrollees. By contrast, the gas consumption of future ABP enrollees is higher than non-enrollees by about 10% year-round. There are several possible explanations for these differences. Generally, we would expect ABP consumption to be higher because it is associated with larger houses and more affluent customers. High seasonal (winter for gas and summer for electric) consumption and bills, by contrast, appear to motivate enrollment in a BB program.

Figure 2 provides the same plots for electric consumption. It is evident that high electric use and bills are a more likely driver of BB participation. The increase in summer consumption for future BB enrollees is dramatic compared to both non-enrollees and future ABP enrollees. It is particularly clear that future BB enrollees' increased consumption is cooling related in contrast to the future ABP participants whose increased consumption is a constant magnitude throughout the year. In light of this, the slight increase in future BB enrollees' gas consumption in the winter could be a result of a correlation between heating and cooling demand driven by lack of insulation, for instance.

Figure 2: Average daily consumption (kWh) before ABP and BB enrollment – waves 3 and 4



5 RESULTS

We present results from the fixed effects model for each cohort in this section.

5.1.1 Pooled fixed-effects model results

Table 5 provides estimates of the fixed-effects model coefficients.[6] Since the dependent variable (average daily therms) is logged, model coefficients are percent changes in consumption associated with each independent variable. For instance, the coefficient on the post HER treatment variable indicates that there is -0.4% reduction in average gas use because of HER treatment. The model standard errors are clustered at the household level because monthly consumption values for a given household are not independent. This approach allows us to avoid standard errors that over-estimate the precision of estimated coefficients.

Table 5: Pooled fixed effects model estimates for HER wave 3 and wave 4

	Wave 3 Model Estimates			Wave 4 Model Estimates		
	Coefficient Estimate	Standard Error	P value	Coefficient Estimate	Standard Error	P value
Post HER treat	-0.004	0.001	0.001	-0.002	0.001	0.030
on ABP	0.021	0.004	0.000	0.007	0.005	0.105
On BB	0.044	0.004	0.000	0.044	0.004	0.000
Post HER treat on ABP	-0.027	0.002	0.000	-0.024	0.002	0.000
Post HER treat on BB	-0.007	0.002	0.000	-0.018	0.002	0.000

5.1.2 Effects of ABP and BB

Like our finding for electricity, the parameter estimates on ABP and BB indicate that enrollment in these payment plans are associated with statistically significant increases in consumption. We estimate a 2.1% and a 0.7% increase in gas consumption for HER wave 3 and HER wave 4 ABP enrollees, respectively, and a 4.4% increase in consumption for BB users in both waves (Table 5).

6 The coefficient estimates for these variables include the interaction effects between ABP and BB for a small subset of HER households that are in both. We couldn't identify a statistically significant effect for the interaction term between these two plans and, thus, do not estimate it separately in the model.

Our prior study on the association of these payment plans and electricity consumption changes were an effort to replicate Sexton's work using California data. In that work, we identified increases in electricity consumption for PG&E residential customers using these payment plans. Moreover, the estimated increases in electricity consumption are similar to the increases we identify in this study for PG&E's gas residential customers enrolled in these plans.

However, our estimated increases in energy use are lower than those reported in Sexton's study; Sexton had found a 4% increase in electricity use for those on ABP and a 6% increase for those on BB. These differences may be due to, among other things, possible disparities in the structure of the plans and differences in how these programs are marketed in the two jurisdictions.

More importantly, however, our study estimates the short-term effect of enrollment in these payment plans for the subset of enrollees who joined during the analysis period of the prepared PG&E's HER data; Sexton had a long time-series that included all ABP and BB enrollees, and included observations from periods prior to ABP and BB enrollments for all those customers. PG&E's data for HER wave 3 that we used covers the period July 2012 until December 2015 while HER wave 4 is based on data from March 2013 until the end of 2015. There are residential customers in these cohorts that have been on ABP or BB for much longer than the start of these study periods. We were not able to estimate the changes in consumption for these types of customers since we don't have data on their energy use prior to their enrollment in these plans. Our estimates in both studies are thus, the short-term effects of enrollment in ABP and BB for the customers enrolling during this period.

5.1.3 Effects of HER treatment on ABP and BB enrollees

As in our prior study on ABP and BB for PG&E, we also estimated the additional (marginal) interactive effects of HER treatment on ABP and BB enrollment. As Table 5 indicates, ABP enrollees receiving HER treatment reduced their consumption by 2.7% relative to those who did not get HER messaging in wave 3 and by 2.4% in wave 4. Similarly, BB enrollees that received HER treatment reduced their consumption by 0.7% in wave 3 and 1.8% in wave 4. These reductions are all statistically significant.

We present the total effect of HER treatment for those enrolled in ABP and BB by combining the ABP/BB specific effects with the baseline HER effect in Table 6. The total HER treatment effect for ABP enrollees is about 3%, and range from 1% to 2% for BB enrollees in both HER waves. HER treatment appears to have a stronger effect on gas consumption than on electric use for those enrolled in these payment plans; the total HER treatment effect for both ABP and BB enrollees were a full percentage lower in the electric case. This is probably because cooling needs are greater than heating needs for customers in this territory, and thus, less amenable to reduction. In addition, it could indicate that heating needs can be met with sources other than gas while electricity is the sole source available to meet cooling needs.

Table 6: Estimate of total HER effect for ABP and BB enrollees in HER wave 3 and wave 4

	Wave 3 Model Estimates			Wave 4 Model Estimates		
parameter	Coefficient Estimate	Standard Error	P value	Coefficient Estimate	Standard Error	P value
Total HER effect on ABP	-0.030	0.002	0.000	-0.026	0.002	0.000
Total HER effect on BB	-0.010	0.002	0.000	-0.020	0.003	0.000

An alternative way to look at these effects is provided in Table 7. The outcome for each group is presented relative to HER control group customers not enrolled in either ABP or BB.

Table 7: Gas consumption changes associated with ABP, BB, and HER in HER wave 3 and 4

	HER Wave 3		HER Wave 4	
	Control	Treatment	Control	Treatment
no ABP/BB	0%	-0.4%	0%	-0.2%
ABP	2.1%	-0.9%	0.7%	-1.9%
BB	4.4%	3.3%	4.4%	2.3%

It is evident that HER treatment has a greater effect on ABP and BB enrollees than those not enrolled in either program. Like in electricity, HER treatment appears to shave off the entire increase in consumption for those on ABP in both waves. For instance, while ABP enrollees in wave 3 use 2.1% more gas relative to those not on ABP, an amount greater than this increase is shaved off by HER messaging. HER treatment also counteracts about 25% to 50% of the increase associated with BB.

As Table 8 indicates, the increases in electricity use associated with ABP and BB are on par with gas consumption increases from these two programs. HER treatment also wipes out ABP related electricity consumption increases and decreases BB-related electricity consumption increases by about 20% to 30%.

Table 8: Electricity consumption changes associated with ABP, BB, and HER in HER wave 3 and 4

	HER Wave 3		HER Wave 4	
	Control	Treatment	Control	Treatment
No ABP/BB	0%	-1.0%	0%	-0.7%
ABP	1.6%	-0.2%	1.1%	-0.8%
BB	4.7%	3.8%	3.8%	2.5%

5.1.4 Estimated therm impact

We provide the therm impact of ABP and BB in this section. We examine therm changes associated with these payment plans on a per household basis in the two different waves. These changes are measured relative to baseline gas consumption, which is the amount of therms used by households prior to ABP or BB enrollment and HER treatment. We provide these results in Table 9.

Table 9: Therm changes association with ABP and BB, and HER

	HER Wave 3		HER Wave 4	
	Control	Treatment	Control	Treatment
no ABP/BB		-1.4		-1.0
ABP	8.2	-3.4	3.3	-8.4
BB	16.7	12.7	19.5	10.4

Annual baseline consumption level (of 382 therms) for ABP and BB in wave 3 is based on the average gas use of customers not on either payment plan prior to July 2013, when the HER program began. For wave 4, annual baseline consumption (of 444 therms) is based on the average gas use of those not on either payment plan prior to March 2014, the start of HER treatment for this wave. We use the estimated changes in gas consumption associated with ABP and BB, and HER treatment summarized in Table 7 to compute the therm changes.

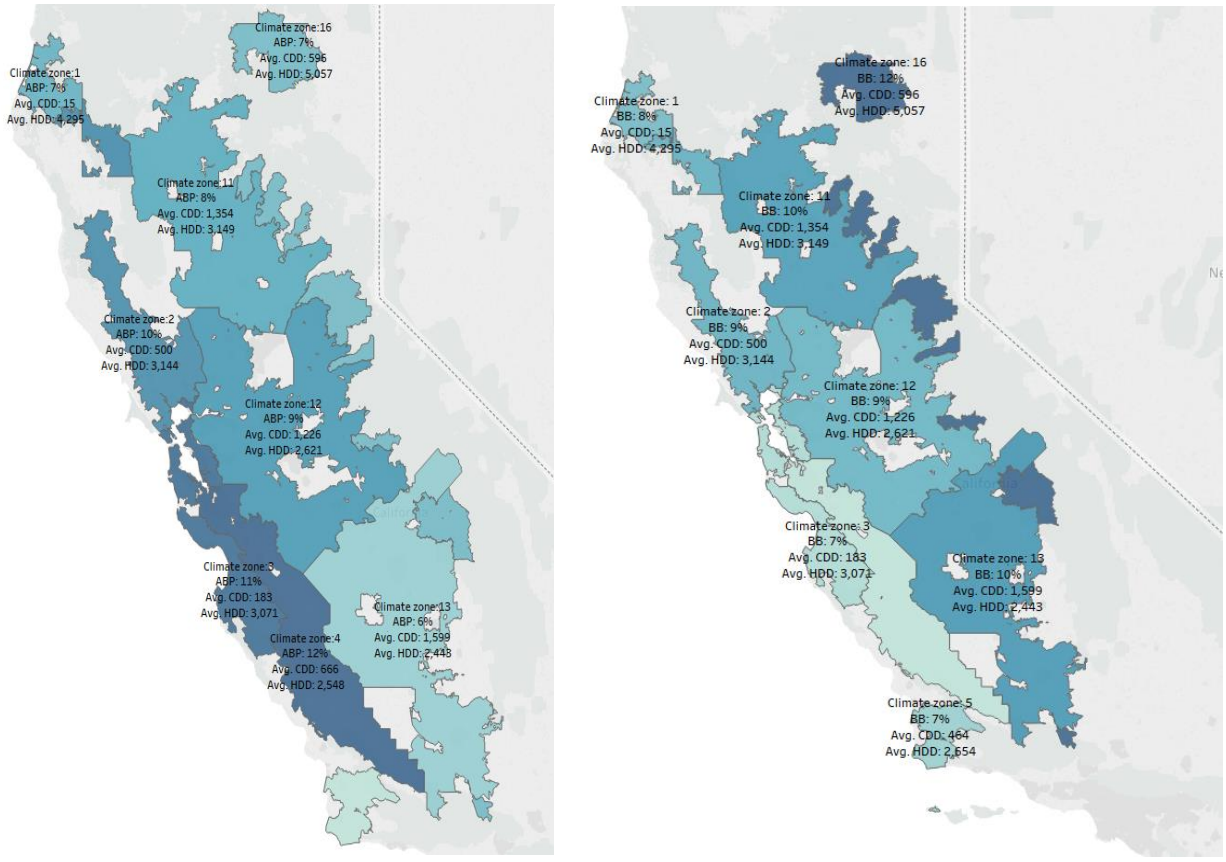
The estimated gas consumption increase per household associated with ABP is 8.2 therms for wave 3 and 3.3 therms for wave 4. ABP households that received HER treatment, on the other hand, reduced their gas consumption by 3.4 to 8.4 therms per household.

The increase in gas consumption associated with BB is higher than with ABP at 16.7 to 19.5 therms per household. HER treatment counteracts these increases partially. Wave 3 BB enrollees that received HER treatment used 12.7 therms more gas per household than baseline while wave 4 BB enrollees increased their gas use by 10.4 therms per household relative to baseline.

6 REMARKS

We present plots that indicate the concentration of ABP and BB enrollment by climate zone in 2015. The plots indicate the percent of residential customers that were on a payment plan, and also provide average HDD (base 65F) and CDD (base 80F) for each climate zone.[7] Figure 3 presents the concentration of ABP (left panel) and BB (right panel) by climate zone. In each panel, the more saturated color (the darker the blue shade) the higher the percent of customers on ABP or BB.

Figure 3: 2015 concentration of ABP and BB by climate zone



The concentrations of ABP and BB customers ranges from 6 to 12% across climate zones. Thus, both programs have substantial enrollment in all climate zones. It is also evident, however, that the higher

[7] Average CDD and HDD values for each climate zone are from https://www.pge.com/includes/docs/pdfs/about/edusafety/training/pec/toolbox/arch/climate/california_climate_zones_01-16.pdf.

concentrations of ABP customers are in the coastal climate zones while the concentrations of BB are higher in the inland and mountain climate zones. The highest concentrations of ABP (averaging 10% to 12%) are in climate zones 2, 3 and 4 covering most of the San Francisco Bay Area while the highest concentrations of BB are in the mountain climate zone of 16, and the northern California valley and Central Valley climate zones of 11 and 13 averaging 10% to 12%. The areas of high BB concentration appear to be associated with higher cooling and heating demand and lower median incomes. In contrast, ABP appears to be primarily associated with areas of higher income as indicated by the greater concentration of ABP customers in the relatively affluent Bay Area.

The association of ABP enrollment with higher income areas is not inconsistent with Sexton's theory of the loss of price salience as a mechanism for increase in consumption of customers on these types of payment plans. While a higher income could facilitate losing touch with prices, the decision to join is not related to consumption levels. The change in consumption levels is not due to a perceived change in price but a reduction in the salience of price as a driver in determining consumption levels.

By contrast, BB enrollment is likely to be driven by the desire to reduce high bills, caused by cooling in the summer or heating in the winter. BB will explicitly facilitate customers with fixed or limited funds to cool as much as desired during the summer, for instance. The effective cost of electricity is lowered during the summer months while the effective cost of gas is lowered in the winter. These lower bills are accompanied by higher bills the rest of the year, but that may be a secondary issue when the demand for heating or cooling is high. BB may also increase price insalience because the direct connection between bill magnitude and recent consumption is broken. However, unlike ABP, where price insalience is hypothesized by Sexton to be the primary driver of increased consumption, it is difficult to ignore the consumption-related motivations that could be part of the BB enrollment decision. This connection between the decision to enroll and consumption makes the price insalience solution to self-selection less convincing. In turn, this makes the BB results less reliable.