Appendix: *Success, Failure, and Information: How Households Respond to Financial Rewards for Energy Conservation*

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Appendix A Program Overview

A.1 Online Portal

BC Hydro provides households participating in a conservation challenge with an online portal showing their electricity use and progress towards their target. The online portal includes information on monthly electricity use compared to the same month the previous year and their 10% conservation target, with an example shown in Figure A.1a. In addition to monthly electricity use the online portal displays a household's cumulative progress towards their annual 10% conservation target, Figure A.2b. The way the portal displays information may have changed over the life of the program.

A.2 Data and Household Characteristics

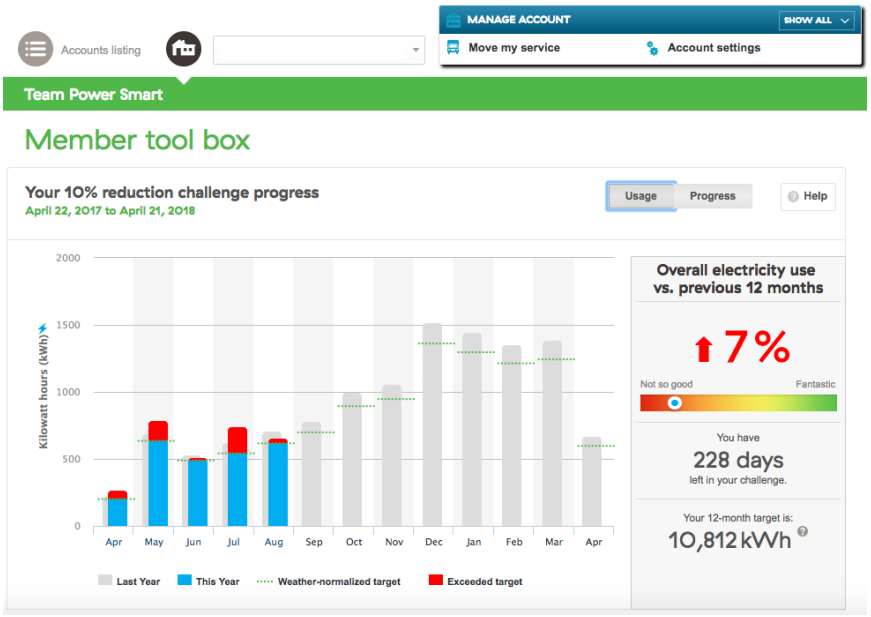
The sample of households provided by BC Hydro was a random sample of participant households from the British Columbia Lower Mainland region which covers 60% of the province's population (BCStats, 2016). Temperatures range from a summer average of 18°C to winters averaging 4°C (ECCC, 2017). Electricity use in British Columbia peaks in the winter due to the widespread use of electricity for heating and the limited use of air conditioning in the summer, and BC Hydro estimates that 46% of residential electricity use in British Columbia comes from electric heating.

Table A.1 compares the household characteristics of program participants to non-participants. The principal difference is that participants in Team Power Smart are more likely to live in apartments or townhouses compared to single family dwellings and are more likely to use non-electric heating. BC Hydro classifies households into heating categories based on surveys of residents and information on the building where the meter is installed. Non-Electric are households that heat primarily from sources other than electricity. Electric are households that heat primarily from electricity, and Unknown are unclassified households. Importantly, BC Hydro does not classify households into heating categories based on their observed electricity use. Differences between participant and non-participant households cannot be attributed to different self-selection into the program among household types. This is because BC Hydro engages in a range of advertising for Team Power Smart that will differently affect households awareness of the program and thus their likelihood of becoming participants.

Figure A.2 shows the average electricity use for these households over the panel. Non-participant

Figure A.1: **BC Hydro's Online *Member Tool Box***

(a) **Monthly Challenge Progress**



(b) **Cumulative Challenge Progress**

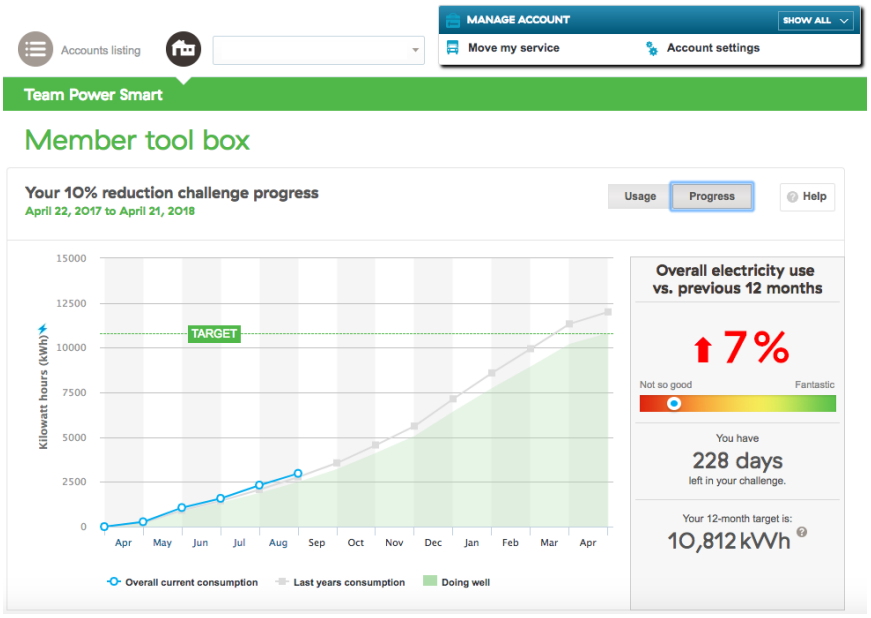


Table A.1: **Participant and Non-Participant Characteristics**

	Participants		Non-Participants	
	N	%	N	%
Building Type				
1 Story Single Family Dwelling	3,426	39	8,764	46
2 Story Single Family Dwelling	2,422	27	5,088	26
1.5 Story Single Family Dwelling	374	4	977	5
Apartment	1,282	14	1,813	9
Townhouse	1,102	12	1,677	9
Other	231	5	931	5
Heating Type				
Non-Electric	5,059	57	9,687	50
Electric	2,610	29	7,294	38
Unknown	1,208	14	2,269	12
Bedrooms				
0	11	0	12	0
1	469	5	703	4
2	1,452	16	2,745	14
3	3,284	37	6,709	35
4	2,036	23	4,569	24
5 or more	1,625	18	4,512	23
Total HH's	8,877	100	19,250	100
	Participants		All Non-Participants	
	Mean	SD	Mean	SD
kWh	903	584	996	658
Average Monthly Bill	$62		$69	
Value ($1,000)	$662	$467	$721	$575
Floor Area (Square Feet)	2016	934	2123	997

Notes: This table shows the building characteristics of participant households and non-participant households. These households are chosen from a random selection of British Columbia lower-mainland households, which is primarily an urban and suburban area concentrated around the Vancouver metropolitan area.

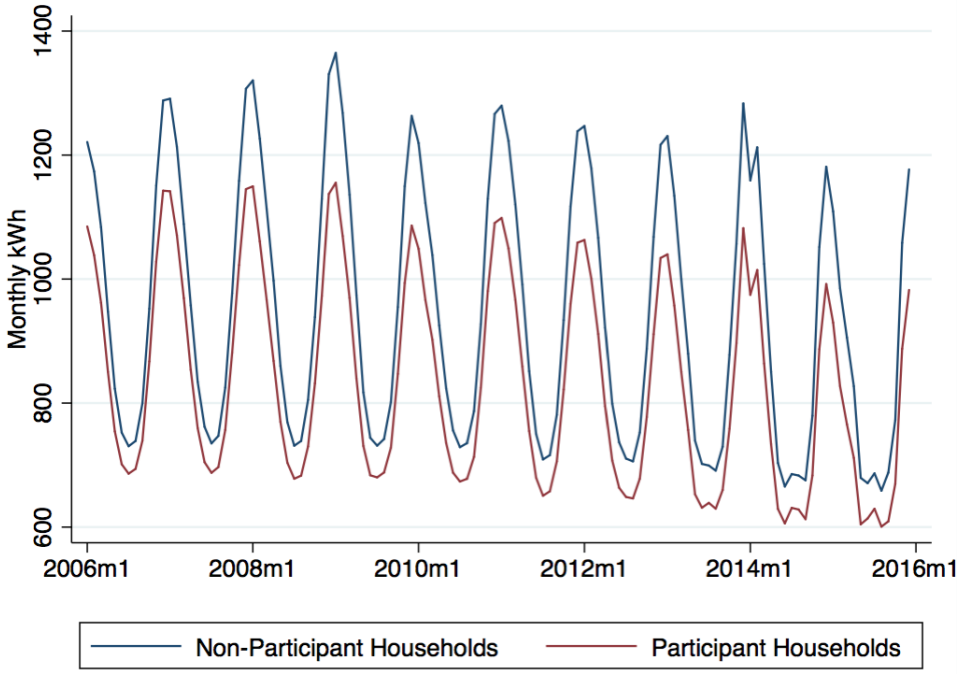
households have significantly higher electricity use, particularly in the winter months, and electricity use is declining over the period studied among both participants and non-participants.

A.3 Strategic Sign Up

Households could in theory increase their electricity use (or stop any ongoing efforts to reduce their electricity use) to create a new higher baseline that would make their subsequent conservation challenge easier to achieve. Figure A.3 shows no obvious evidence of this; most households, if they continue to additional challenges, begin their next challenge in the first 3 months immediately after completing their prior challenge and there is no obvious bunching at 12 months.

The option to undertake a subsequent challenge does not expire; households can sign up for another challenge immediately or postpone indefinitely. Figure A.4 shows the distribution of start dates for

Figure A.2: **Time Trends in Electricity Use**



Notes: Average monthly electricity use for participant households and the full sample of non-participant households.

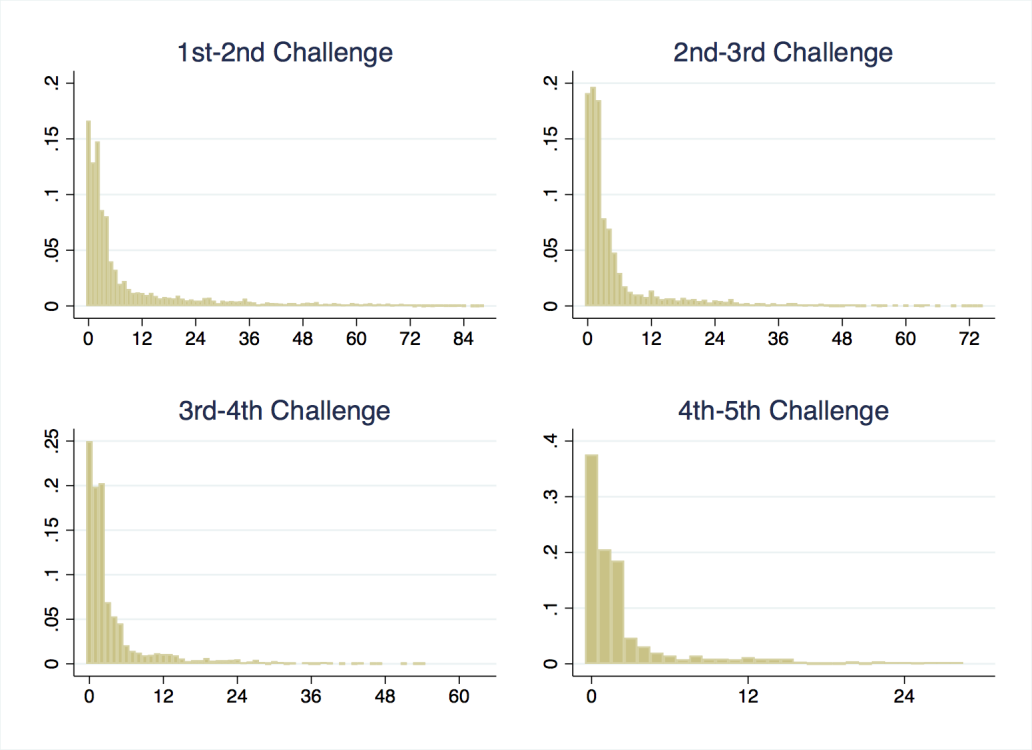
challenges one through four. New households continually enroll in TPS throughout the panel and as time proceeds households that complete challenges continue to subsequent conservation challenges. Several dates show large increases in sign-ups; these are likely due to periods of significant promotion of the TPS program by BC Hydro as they do not coincide with previous months of unusually large or small electricity use or unusual changes in weather.

A.4 The Weather Adjustment

Importantly, the weather-adjustment algorithm used by BC Hydro resulted in large adjustments to households' electricity conservation beyond those necessary to correct for weather changes. Adjusting for weather is not an exact science. Some households heat with electricity more than others, some households that do not principally heat with electricity - and so are defined as non-electric heat households - still make significant use of electric heat via baseboard heaters, and household-specific characteristics like insulation or number of residents will drive large differences in the use electricity in response to weather changes. The weather-adjustment algorithm used to calculate credited changes was improved and updated in 2014; I exclude households that use the updated weather-adjustment algorithm.

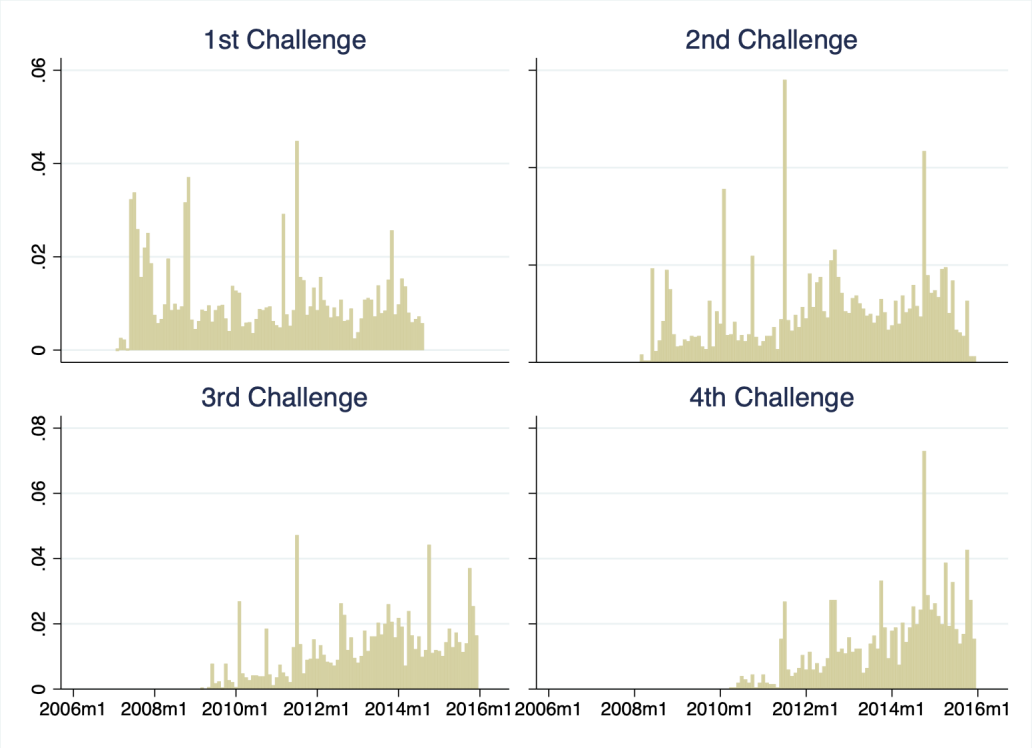
The weather adjustment was applied to the baseline used to calculate households credited reductions. Because of this, households were not aware of the magnitude of shock applied to their conservation. This conservation shock strengthens the fuzzy regression discontinuity identifying assumptions by me-

Figure A.3: **Delay Between Conservation Challenges**



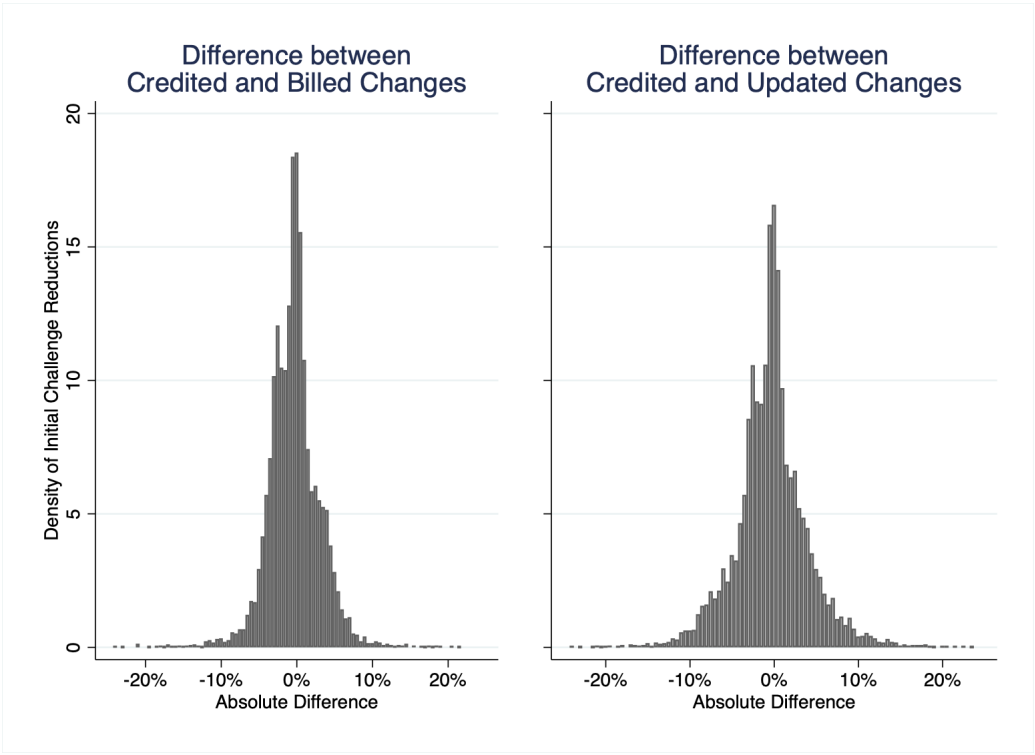
Notes: These histograms show the number of months households wait between conservation challenges. The majority of households which continue to additional challenges do so shortly after completing their prior challenge. The median wait after the 1st challenge is 3 months, 2 months after the 2nd challenge, 2 months after the 3rd challenge, and 1 month after the 4th challenge.

Figure A.4: **Distribution of Challenge Start Dates**



Notes: These histograms show the start date for conservation challenges one through four. Several dates show large increases in the number of households starting a challenge. Periods of increased sign up do not coincide with unusual weather, seasons, or consumption, and are likely due to promotion of Team Power Smart by BC Hydro.

Figure A.5: **Weather Adjustment Discrepancies**



Notes: The left panel, Credited and Billed changes, is a histogram of the absolute differences between the changes in electricity use credited to a household after applying the first weather-adjustment algorithm, and the changes in their billed electricity use. The right panel, Credited vs Updated Changes, is the histogram of differences between credited changes and changes in billed electricity use where the effect of weather has been removed as recommended by BC Hydro and used in the updated algorithm. Differences are in absolute percentage points such that a 10% Absolute Difference is equivalent in magnitude to the 10% conservation target.

chanically randomizing households into and out of success in their conservation challenge.

The first panel of Figure A.5 shows a histogram of the difference in absolute percentage points between credited and billed changes in electricity use during a households initial conservation challenge. This is the difference between the reductions in electricity use households were told they achieved and the reductions in physical electricity use that actually occurred. These differences are not small; they have a mean of -0.43% and a standard deviation of 4.2%. In the second panel I show the difference between credited changes used to evaluate a household's success and changes in electricity use using an updated algorithm where the effect of weather on electricity use has been removed as currently recommended by BC Hydro. These have a mean of -0.4% and standard deviation of 5.0%. This shows that the weather adjustment caused many households to receive shocks to their electricity conservation beyond that necessary to adjust for changes in weather, and comparable in magnitude to half of a households' 10% conservation goal.

Table B.2: **Pre-Program Trends in Electricity Use**

	(1)	(2)	(3)	(4)	(5)
β_1 : Date	-0.00030	-0.00034	-0.00034	-0.00061	-0.00053
	(0.00015)	(0.00010)	(0.00008)	(0.00006)	(0.00005)
β_2 : Date×Participants	0.00032	-0.00001	-0.00003	-0.00009	0.00013
	(0.00021)	(0.00016)	(0.00013)	(0.00011)	(0.00012)
Pre-Program Years	2	3	4	5	6
Non-Participant IDs	8877	8877	8877	8877	8877
Participant IDs	6778	5477	4609	3638	2162
Observations	375719	516743	647327	750898	794805

Notes: β_1 : *Date* is the pre-program time trend common to participant and non-participant households. β_2 : *Date* × *Participants* is the additional time trend specific to participant households. Pre-Program Years is the length of time for which time trends are estimated and excludes all households that start a challenge within six months after the given pre-program. The six month period is to avoid pre-treatment trends that could include anticipation effects in the final months pre-treatment. Standard errors in parentheses clustered at the household level. *** p<0.01, ** p<0.05, * p<0.1.

Appendix B Event Study Design

B.1 Parallel Trends Assumption

Evidence that the parallel trends assumption holds is obtained by comparing pre-treatment trends between participant and non-participant households. I estimate the following specification,

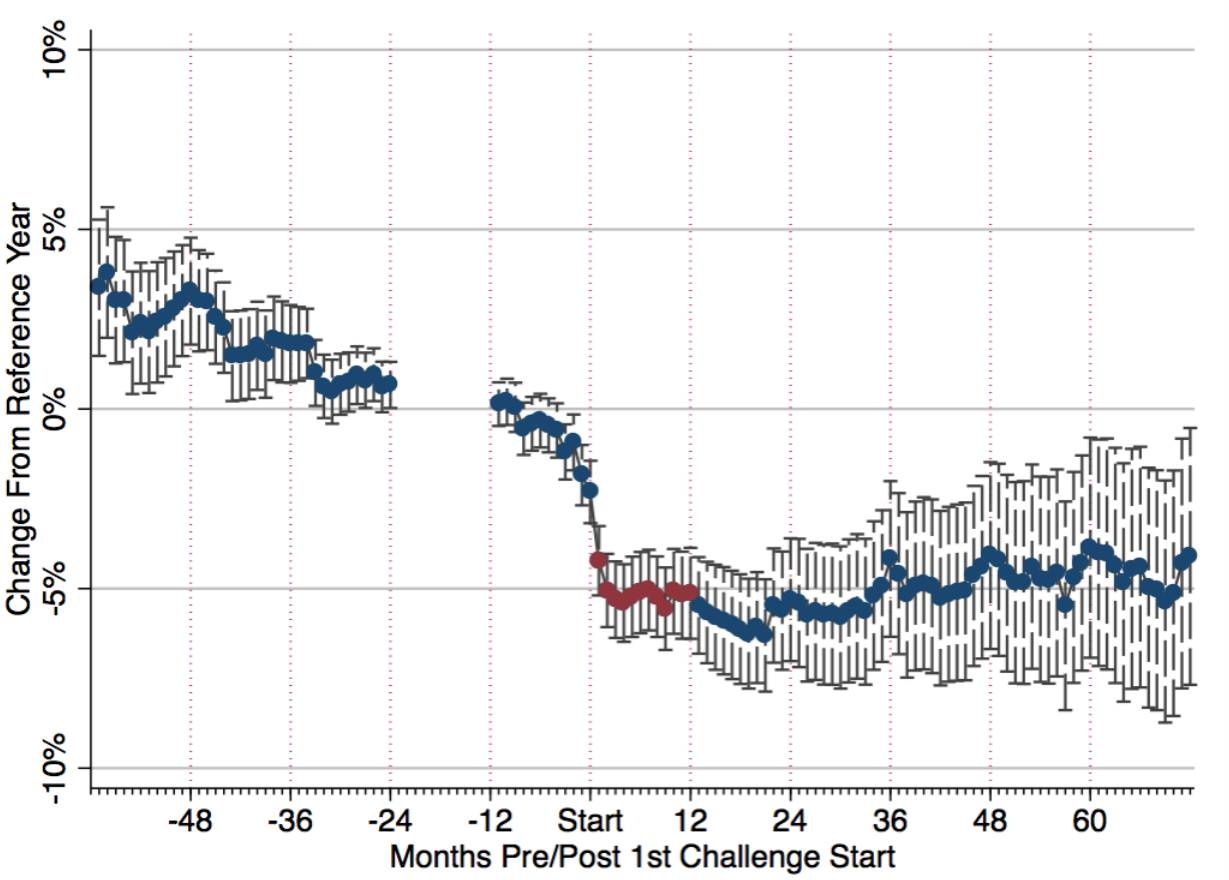
$$y_{it} = \beta_0 + \beta_1 m_t + \beta_2 m_t \times TPS_i + \beta_3 TPS_i + \epsilon_{it} \quad (1)$$

where y_{it} is log monthly electricity use, m_t is the date, and TPS_i is an indicator equal to one if household i is a Team Power Smart participant household. The only pre-treatment period available to all households is the year 2006. To test trends over multiple years I estimate specification (1) for several different time periods and include only participant households that do not begin a conservation challenge until 6 months after the initial pre-treatment years indicated. Table B.2 shows the results where β_1 is the percent change per month for non-participant and participant households and β_2 is the additional monthly percent change for participant households. Participant households do not have a significantly different, at the 1% level, pre-treatment trend from non-participants. The magnitude of diverging time trends is also small. Taking the largest point estimate of different trends, $\hat{\beta}_2 = 0.00032$, would imply an upper bound to the potential bias in estimated program effects of only 0.4% at the end of the first conservation challenge.

B.2 Event Study Robustness Checks

This section presents several event-study robustness checks. Figure B.6 plots the event study estimates of equation (1) estimated without non-participant control households. This estimation strategy identifies the program effects by exploiting the variation in timing in when a household starts their

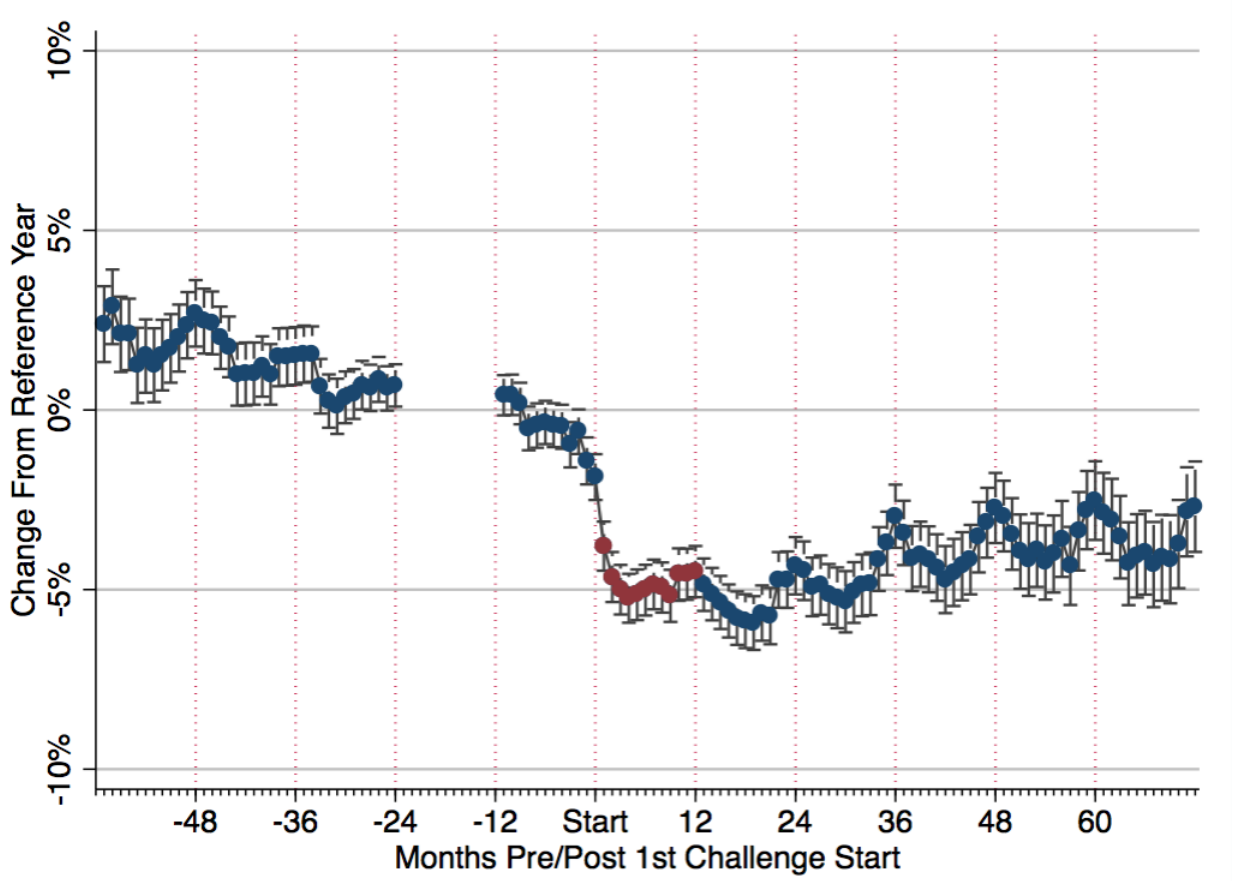
Figure B.6: **Estimated Treatment Effects For Participant Households Only**



Notes: This figure plots estimates of $\hat{\beta}_\tau$ and 95% confidence intervals from equation (1) estimated for participant households only. Estimates $\hat{\beta}_\tau$ are ordered by event-time τ and point estimates in red denote the 12 months of the initial conservation challenge. The gap between -11 and -23 is the excluded reference period; $\hat{\beta}_\tau$ identifies the percent change in electricity use relative to the average use in this period. Point estimates are in Table E.8, specification (2).

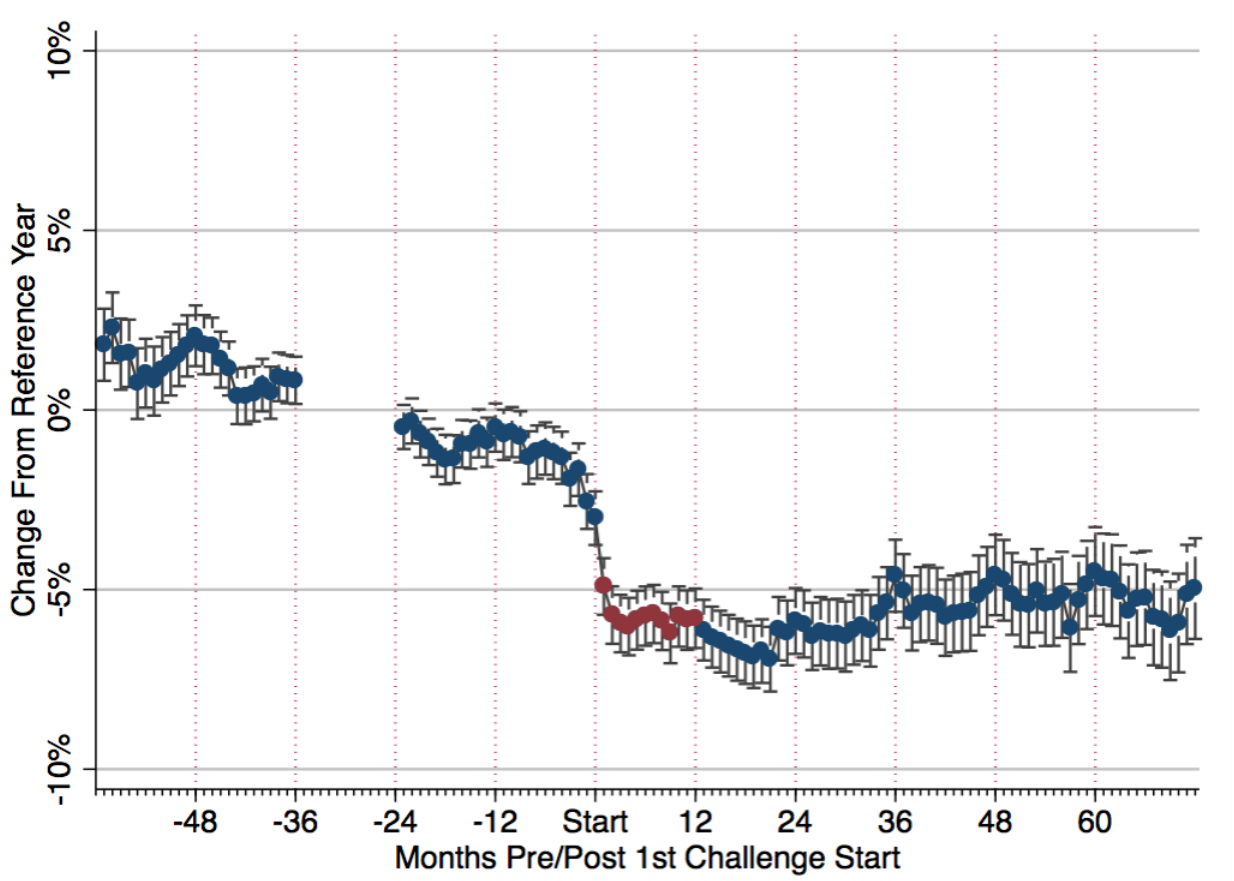
first conservation challenge. Households that start a challenge later in the panel serve as the control population for households that undertake a challenge earlier in the panel. Figure B.6 shows that the estimated pre-treatment trend is not due to diverging trends between participant and non-participant households. Confidence intervals are larger due to the lack of non-participant households for identifying the date fixed effects. Figure B.7 plots the estimated program effects including the full set of non-participant households, instead of the random sub-sample of non-participant households with the same composition of building type and heating characteristics as participant households. Figure B.8 plots estimated program effects using an alternate baseline period of the third year prior to the initial conservation challenge, instead of the second pre-program year. Figure B.9 plots all estimates for households undertaking separate numbers of challenges on the same plot to provide an alternative comparison of their trends.

Figure B.7: **Estimated Treatment Effects For All Households**



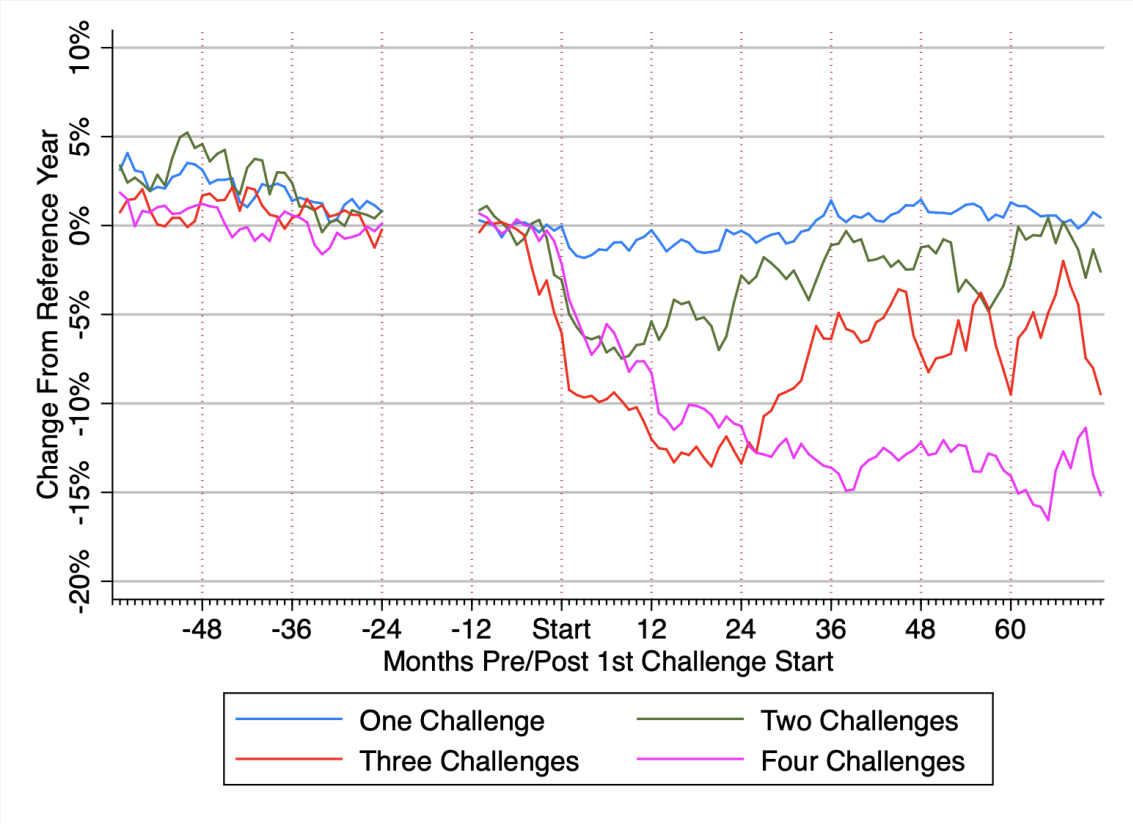
Notes: This figure plots estimates of $\hat{\beta}_\tau$ and 95% confidence intervals from equation (1) for the unbalanced set of participant and non-participant households. Estimates $\hat{\beta}_\tau$ are ordered by event-time τ. Point estimates in red denote the 12 months of the initial conservation challenge ($\tau = [1..12]$). The additional yearly variation in this figure, compared to Figure 1(a), arises due to the higher share of electric-heating households among the full set of non-participant households, compared to program participants. Electric heating households have higher seasonal variation than non-electric households which the common date fixed effects cannot fully absorb.

Figure B.8: **Estimated Treatment Effects For All Households — Alternate Baseline**



Notes: This figure plots estimates of $\hat{\beta}_\tau$ and 95% confidence intervals from equation (1) for all participant and non-participant households. Estimates $\hat{\beta}_\tau$ are ordered by event-time τ. Point estimates in red denote the 12 months of the initial conservation challenge ($\tau = [1..12]$). The pre-treatment period is denoted by the months prior to *Start* ($\tau \leq 0$). The visual gap in estimates between months $\tau = -24$ and $\tau = -36$ is the excluded reference period. $\hat{\beta}_\tau$ identify the percent change in electricity use relative to the average electricity use within a household during this excluded reference year.

Figure B.9: **Estimated Treatment Effects** - Overlapping Challenges



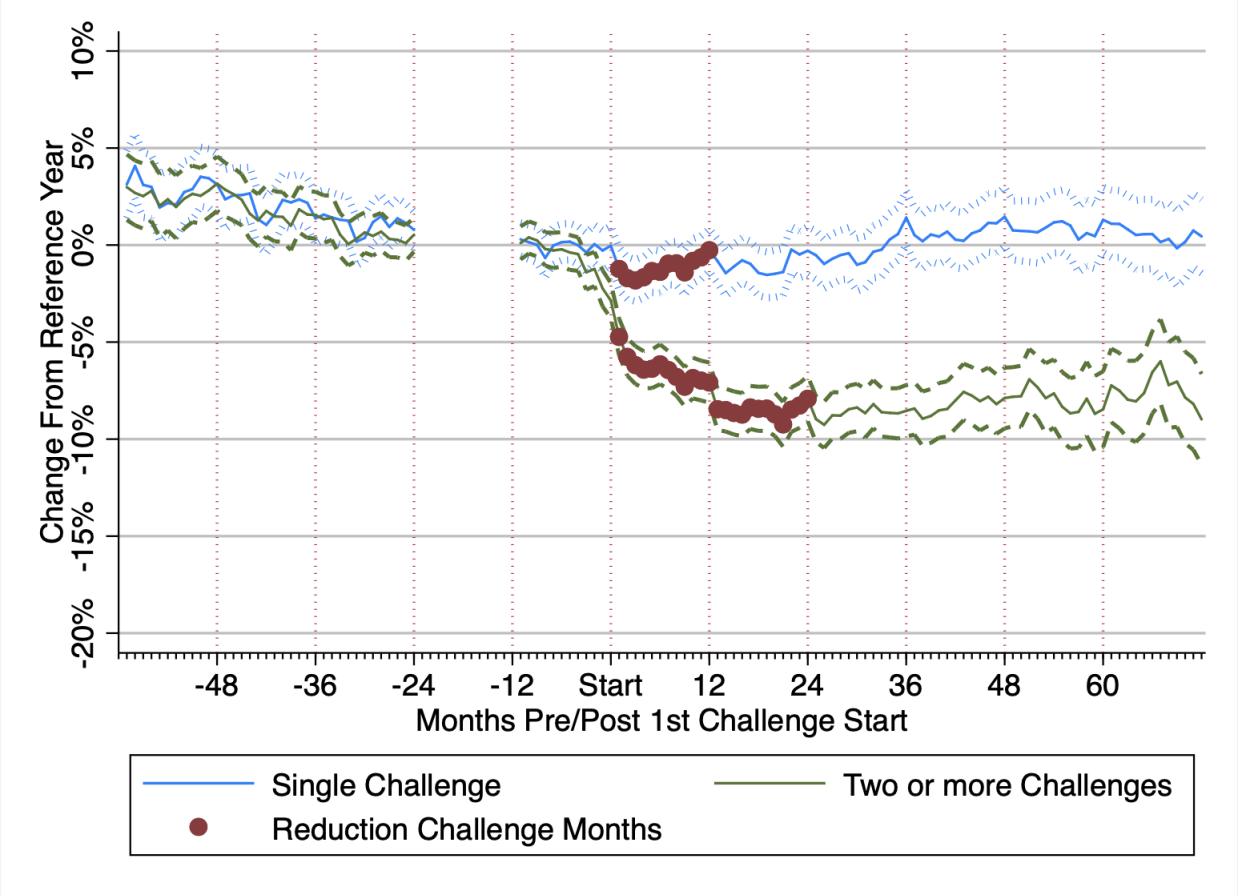
Notes: This figure plots estimates of $\hat{\beta}_\tau$ for mutually exclusive groups of participant households depending on how many challenges they undertake. This repeats the estimates in Figures 1 and 2, excluding confidence intervals for clarity. Estimates $\hat{\beta}_\tau$ are ordered by event-time τ. Point estimates in red denote the 12 months of the initial conservation challenge ($\tau = [1..12]$). The pre-treatment period is denoted by the months prior to *Start* ($\tau \leq 0$). The visual gap in estimates between months $\tau = -24$ and $\tau = -36$ is the excluded reference period. $\hat{\beta}_\tau$ identify the percent change in electricity use relative to the average electricity use within a household during this excluded reference year.

Comparisons using re-enrolling under original reward value

Figures 1 and 2 used households beginning their initial conservation challenge for the $75 reward, as described in Section 2. However, if households re-enrolled in a subsequent challenge after August 2014, they are subject to the updated Team Power Smart Maintenance Challenge rules. This change in program for re-enrolling households specified that if a household had achieved the 10% reduction target, then they will receive a $25 reward for maintaining last years electricity use BCH 2014. This Team Power Smart update replaced the previous goal of an additional 10% reduction upon re-enrolling.

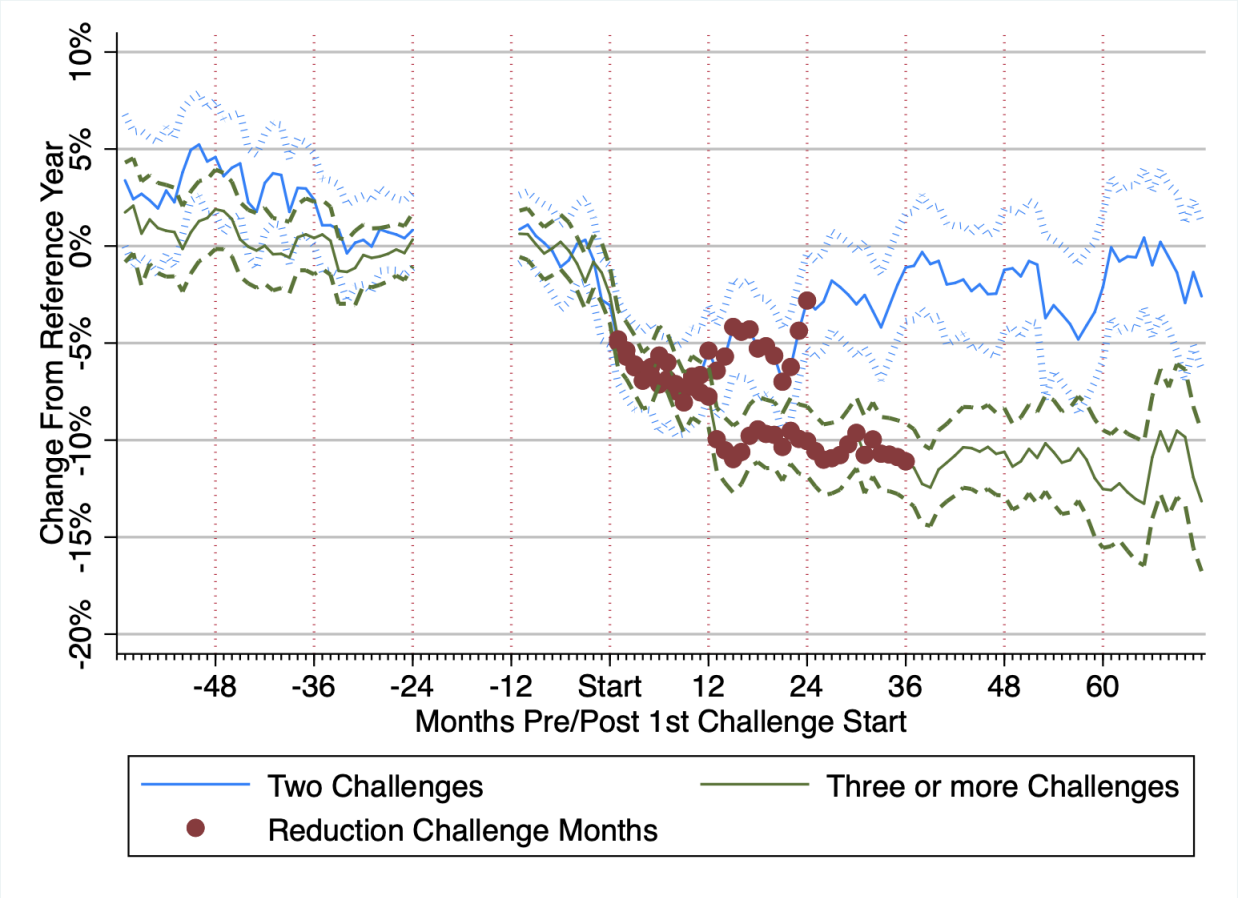
Figures B.10 to B.12, below, present event-study estimates on the sample of households restricted to those that re-enroll in the indicated challenges prior to the program update in September 2014. This demonstrates that results are not sensitive to including households that may have re-enrolled under the September 2014 updated Team Power Smart program.

Figure B.10: **Single Challenge vs Two Or More Challenges**



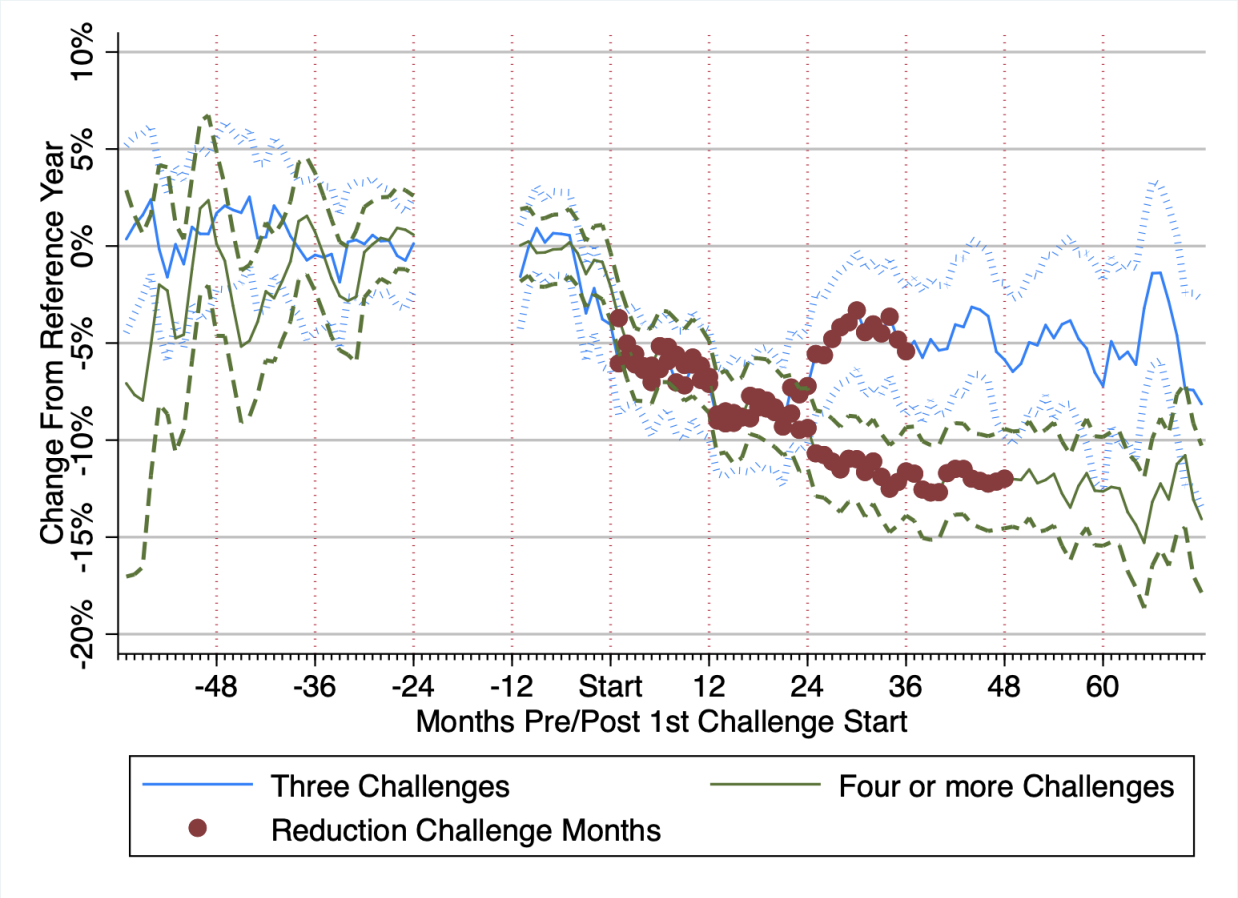
Notes: This figure plots estimated program effects $\hat{\beta}_\tau$ and 95% confidence intervals from equation (3) estimated for two mutually exclusive groups of households.
Estimates in blue are households that undertake a single challenge prior to September 2014, and then end their program participation. Event study estimates in green are for households that undertake at least two conservation challenges, both prior to September 2014, and continued to their second challenge within 12 months of completing their initial challenge. Not shown are estimates θ_g for electricity use during the gap between the first and second challenges. Months 13-24 are estimates of the average change in electricity use among households in their second conservation challenge independent of any gap between challenges. Estimates include individual and date fixed effects and I cluster standard errors at the household level.

Figure B.11: **Two Challenges vs Three Or More Challenges**



Notes: This figure plots estimated program effects $\hat{\beta}_\tau$ and 95% confidence intervals from equation (3) estimated for two mutually exclusive groups of households. Estimates in blue are households that undertook two conservation challenges prior to September 2014, and end their participation after a second conservation challenge. Estimates in green are households that continue to a third conservation challenge, all undertaken prior to September 2014. Estimation sample restricted to households that continue to subsequent challenges within 12 months. Not shown are estimates θ_g for electricity use during the gap between challenges. Estimates include individual and date fixed effects and I cluster standard errors at the household level.

Figure B.12: **Three Challenges vs Four Or More Challenges**



Notes: This figure plots estimated program effects $\hat{\beta}_\tau$ and 95% confidence intervals from equation (3) estimated for two mutually exclusive groups of households. Estimates in blue are households that undertook three conservation challenges prior to September 2014, and end their participation after the third conservation challenge. Estimates in green are households that continue to a fourth conservation challenge, with all four challenges undertaken prior to September 2014. Estimation sample restricted to households that continue to subsequent challenges within 12 months. Not shown are estimates θ_g for electricity use during the gap between challenges. Estimates include individual and date fixed effects and I cluster standard errors at the household level.

Appendix C The Extensive Margin Decision

All households that participate in Team Power Smart have the option of re-enrolling in additional conservation challenges. To explore what correlates with households' decisions to re-enroll in a second challenge I estimate Probit models of the general form of equation (2).[1] C_i is a binary indicator for if a household re-enrolls in a second conservation challenge. X_i is a vector of household characteristics, R_i are changes in electricity use households' received credit for during the first challenge, $1\{R_i \leq \bar{R}\}$ is a dummy variable equal to one if a household was successful in the initial challenge by achieving reductions R_i less than the $\bar{R} = -9.5$ threshold, and P_i is a household's pre-program use measured in standard deviations from the mean of households' 2006 electricity use within heating and building type categories.

$$C_i = \beta \mathbf{X_i} + \theta R_i + \gamma_1 1\{R_i \leq \bar{R}\} + \gamma_2 P_i + \epsilon_i \tag{2}$$

Table C.1 shows the marginal effects from estimating equation (2) with the indicated covariates. The estimation sample are households that begin an initial conservation challenge between February 2007 and February 2013; this restriction limits the sample to households that re-enroll before the Team Power Smart program changed after August 2014. Specification (1) includes households' electric heating category and building type. I use the most common household type, Single Story Single Family Dwellings that heat primarily without electricity, as the reference category; marginal effects show the change in probability of re-enrolling relative to this household type. Specification (1) shows Townhouses are the only household type with a statistically significant, at the 5% level, difference (4.75%) in the probability of re-enrolling. This is consistent with the findings from Subsection 4.3 that electricity conservation is higher for Townhomes compared to other household types. Specification (2) shows that the probability of re-enrolling does not materially differ across the number of bedrooms, household value, or size of the house. Specification (3) shows that households with larger electricity conservation are more likely to re-enroll while Specification (4) demonstrates this is through the channel of passing their conservation challenge. The large magnitude of the coefficient on Success highlights its importance in re-enrollment compared to differences across household characteristics. Taking the largest difference in point estimates across household characteristics in Specification (4) finds Townhouses are 8.6% more likely to re-enroll than homes classified Other. In comparison, households that pass their conservation Challenge are 20.2% more likely to re-enroll. Specification (5) includes a household's Pre-Program use measured in standard deviations from the mean of households' 2006 electricity use, measured within heating and building type categories. This shows that households with higher Pre-Program electricity use are more likely to re-enroll; households three standard deviations above the mean 2006 electricity use are 5.9% more likely to re-enroll. However, this magnitude is not large compared to the effect of Success — Specification (6) — or differences between Townhomes and Other.

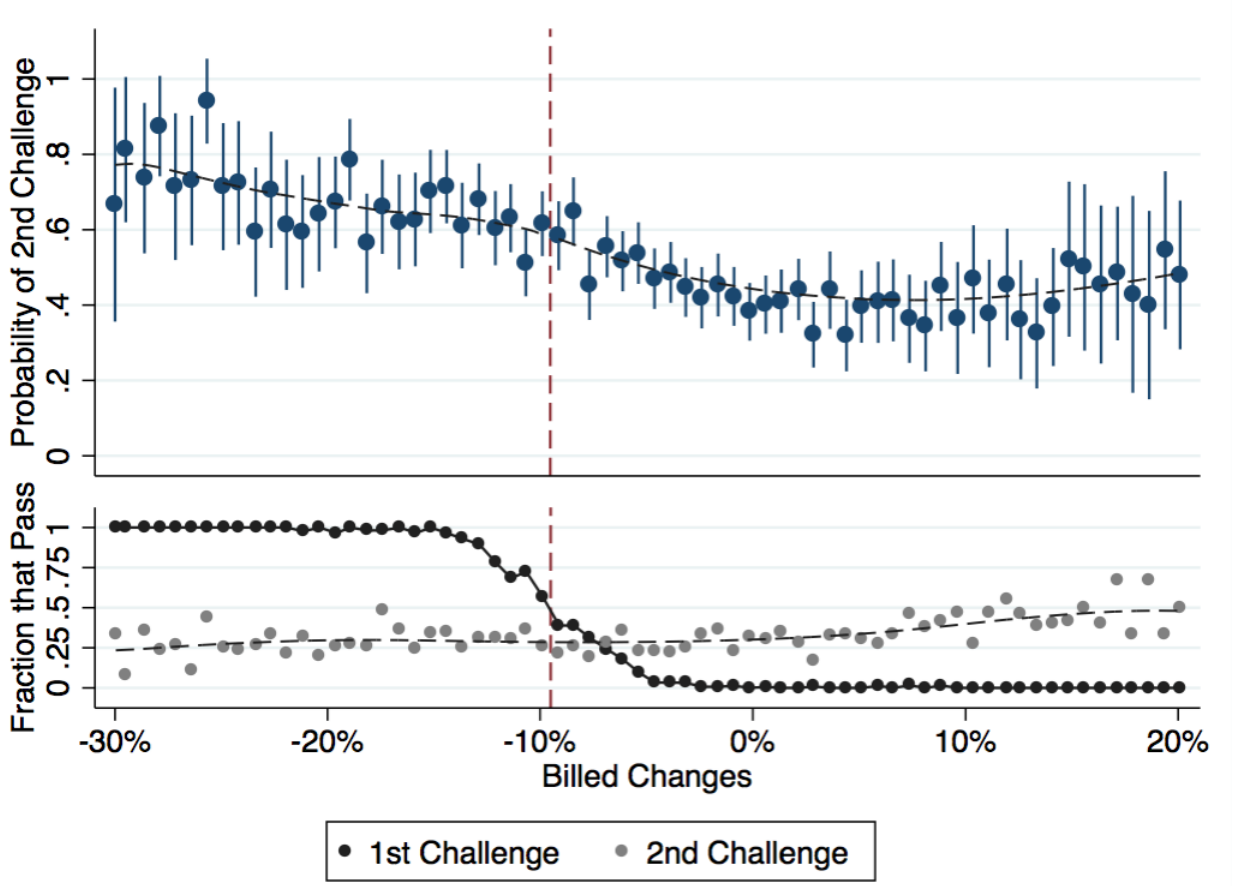
[1] Table C.2 in the Appendix shows broadly consistent results for the decision to re-enroll in a third conservation challenge.

Table C.1: **Probit Model: Re-Enrolling in a Second Challenge**

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: Re-enrollment in a second conservation challenge						
Non-Electric Heat	-	-	-	-	-	-
Electric Heat	0.00368	0.00112	0.00273	-0.00665	0.00335	-0.00682
	(0.0148)	(0.0152)	(0.0149)	(0.0150)	(0.0149)	(0.0151)
Heating Unknown	-0.0141	-0.00335	-0.0122	-0.00736	-0.0134	-0.00655
	(0.0178)	(0.0185)	(0.0179)	(0.0178)	(0.0178)	(0.0178)
1 Story Sfd	-	-	-	-	-	-
2 Story Sfd	-0.00895	0.00879	-0.00873	-0.00658	-0.00915	-0.00684
	(0.0147)	(0.0160)	(0.0147)	(0.0149)	(0.0147)	(0.0149)
1.5 Story Sfd	-0.0161	0.000633	-0.0157	-0.0191	-0.0162	-0.0194
	(0.0294)	(0.0301)	(0.0293)	(0.0297)	(0.0294)	(0.0298)
Apartment	0.00710	-0.0438	0.00725	0.00822	0.00796	0.00897
	(0.0199)	(0.0263)	(0.0201)	(0.0201)	(0.0200)	(0.0202)
Townhouse	0.0475	0.0215	0.0510	0.0569	0.0476	0.0572
	(0.0187)	(0.0206)	(0.0187)	(0.0187)	(0.0187)	(0.0187)
Other (home type)	-0.0361	-0.0501	-0.0334	-0.0295	-0.0362	-0.0295
	(0.0350)	(0.0360)	(0.0350)	(0.0350)	(0.0351)	(0.0350)
Bedrooms		-0.0117				
		(0.00739)				
Value		-0.0195				
		(0.0132)				
Floor Area		-0.0260				
		(0.0239)				
Cred. Changes: R_i			-0.259	0.0218		
			(0.0470)	(0.0357)		
Success: $1\{R_i \leq \bar{R}\}$				0.202		0.200
				(0.0138)		(0.0114)
Pre-Program Use: P_i					-0.0195	-0.0236
					(0.00567)	(0.00570)
Households	7182	6880	7182	7182	7181	7181
Pseudo R^2	0.001	0.003	0.010	0.030	0.003	0.031
χ^2	12.892	23.482	44.942	274.013	24.662	288.620

Notes: This table shows how differences in household characteristics are correlated with the probability of re-enrolling in a second conservation challenge. These are estimated using a Probit model with dependent variable an indicator $C_i = 1$ if household i re-enrolls, $C_i = 0$ if household i does not re-enroll. Estimates are relative to the reference category of One Story Single Family Dwellings that are primarily non-electric heating. Value and Floor area are natural logs, Credited Changes is the percent change in Challenge 1 electricity conservation credited to households, and Success an indicator equal to 1 if a household achieves their Challenge 1 conservation target. Pre-program use is the number of standard deviations between a household's electricity use in 2006 and the average electricity use among households within the same building and heating type category. All coefficients are marginal effects at the covariate means. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Figure C.1: **Probability of Continuing to a Second Challenge: Billed Electricity Use**



Notes: Billed changes are the percent change in billed electricity consumption from the pre-program year to the year of the first conservation challenge. The -9.5% level is shown by the vertical dashed line - note this is not the threshold for success as success was defined from credited - not billed - changes. Point estimates in the top bottom panel are the average probability of continuing to a second conservation challenge within 0.75%-wide bins of billed changes from the first conservation challenge. The dashed line in the top panel shows separate 1st order polynomial fits to households with billed changes above and below the indicated -9.5% threshold.
The bottom panel shows the corresponding fraction who pass their initial reduction challenge (dark connected line) and subsequent challenge (light grey scatter plot.) The dashed grey line in the bottom panel is a 3rd order kernel-weighted local polynomial fit to the fraction of households that pass their second conservation challenge.

Figure C.1 plots the probability of continuing to a second conservation challenge against the reductions in billed—not credited— electricity use from that household's first challenge. Larger reductions in billed electricity use are associated with a greater likelihood of continuing to a subsequent challenge. Figure C.1 also shows the fraction of households succeeding in their challenge. From this we can see some households with reductions greater than 9.5% do not pass their challenge, while other households with reductions less than 9.5% do pass. This occurs because success or failure in a challenge is evaluated from changes in weather-adjusted—not billed—electricity use.

Table C.2 shows the marginal effects from estimating equation (5) for the decision to re-enroll in a third conservation challenge. These results are broadly consistent with those for a second challenge, Table 4, and differ in two ways. First, households are more likely to re-enroll in a third challenge if they use electric heating whereas townhomes are no-longer more likely to re-enroll. Second, magnitude

of passing the second challenge is smaller — 12.3% in Specification (4) of Table C.2— compared to the 20.2% magnitude on Success in the initial challenge from Table 4.

C.1 Continuity at the Discontinuity

The separate 9.5% threshold and 10% target allow me to show that households are not sorting at the discontinuity, despite their partial ability to manipulate the assignment variable. I discuss this identification strategy in detail in Fraser (2019). Figure C.1 plots the average of four household observables across the 9.5% threshold and 10% target. This visually shows no sorting of households by observables around the discontinuity or threshold. Table C.1 shows the results of a linear regression discontinuity model estimated for these four, and two additional observables, at the 9.5% discontinuity. This finds no statistically significant change in the density of observables across different window bandwidths, and supports the identifying assumption that households are not sorting around the 9.5% discontinuity based on observables. The same specification estimated at the 10% target finds no discontinuity.

Figure C.2 shows the histogram of credited changes during households' first conservation challenges. The mass of observations just below the 10% threshold suggests that households may be bunching around the 10% target. This is tested in Figure C.2 which rejects the null of no discontinuity with a one sided p-value of 0.0017. Figure C.3 shows the McCrary (2008) density test at the 9.5% threshold of credited changes. This test fails to reject the null hypothesis of no sorting at 9.5% (one sided p-value 0.117), supporting that if households are bunching while attempting to succeed, they are not doing so at the 9.5% discontinuity threshold and only at the 10% target.

If households were sorting around the 10% target in a way that affects potential outcomes, this would appear as a discontinuity at the 10% threshold in either the probability of continuing in the program or in subsequent electricity conservation. Figure C.4 (a) plots the probability that households re-enroll in a second conservation challenge by their credited changes in the first challenge.[2] The solid vertical line shows the 10% target, and the dashed vertical shows the 9.5% threshold for success or failure. Importantly, the discontinuity in the probability of re-enrolling occurs at the 9.5% threshold for determining success or failure, and not at the 10% target that households are trying to achieve. Figure C.4 (b) plots y_i from equation 6 against the same bins of credited changes during a households' first conservation challenge. The discontinuity occurs again at the 9.5% threshold, not 10% conservation target. That these outcomes change discontinuously only at the 9.5% threshold— and not the 10% target—shows that households are not sorting in a manner that affects potential outcomes.

Figure C.4 plots First Stage and Reduced Form plots corresponding to the bandwidths estimated in Table 3.

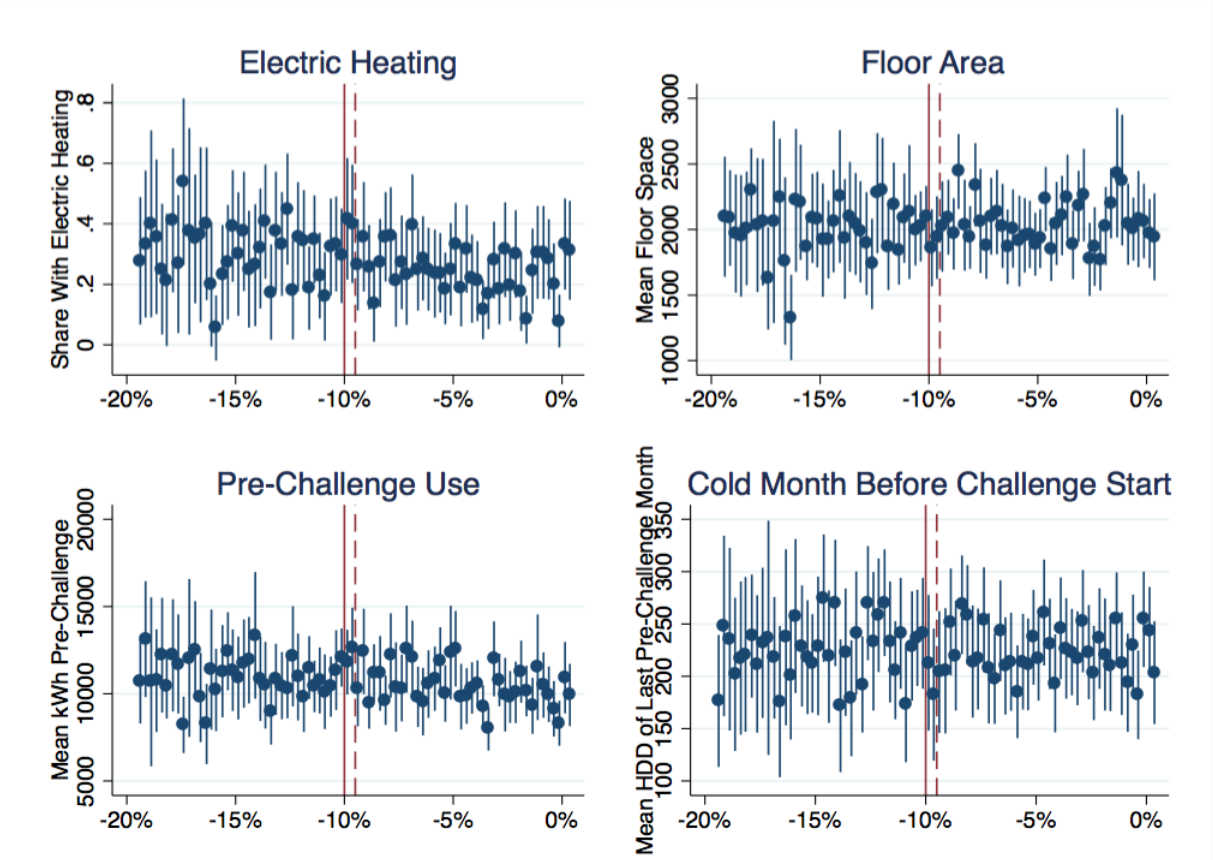
[2]This is similar to Figure 4 but plotted on a narrower ±5% bandwidth around the 9.5% threshold.

Table C.2: **Probit Model: Re-Enrolling in a Third Challenge**

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: Re-enrollment in a third conservation challenge						
Non-ElectricHeat	-	-	-	-	-	-
Electric Heat	0.0545	0.0423	0.0279	0.0449	0.0545	0.0446
	(0.0179)	(0.0185)	(0.0170)	(0.0181)	(0.0179)	(0.0181)
Heating Unknown	0.0326	0.0409	0.0265	0.0347	0.0325	0.0345
	(0.0218)	(0.0225)	(0.0207)	(0.0217)	(0.0219)	(0.0217)
1 Story Sfd	-	-	-	-	-	-
2 Story Sfd	-0.0120	0.00136	-0.0169	-0.0134	-0.0119	-0.0132
	(0.0181)	(0.0195)	(0.0170)	(0.0182)	(0.0181)	(0.0181)
1.5 Story Sfd	0.00146	0.0174	0.00157	-0.00220	0.00175	-0.00219
	(0.0357)	(0.0359)	(0.0342)	(0.0361)	(0.0357)	(0.0361)
Apartment	-0.0134	-0.0608	-0.0171	-0.0157	-0.0133	-0.0161
	(0.0248)	(0.0331)	(0.0232)	(0.0250)	(0.0248)	(0.0250)
Townhouse	0.00196	-0.0217	0.0172	0.00556	0.00209	0.00584
	(0.0227)	(0.0251)	(0.0213)	(0.0226)	(0.0227)	(0.0225)
Other (home type)	0.0714	0.0579	0.00951	0.0760	0.0717	0.0770
	(0.0401)	(0.0419)	(0.0396)	(0.0394)	(0.0399)	(0.0393)
Bedrooms		-0.00281				
		(0.00913)				
Value		-0.0212				
		(0.0162)				
Floor Area		-0.0462				
		(0.0294)				
Cred. Changes: R_i			-0.296	-0.0517		
			(0.0446)	(0.0467)		
Success: $1\{R_i \leq \bar{R}\}$				0.123		0.135
				(0.0173)		(0.0142)
Pre-Program Use: P_i					-0.00586	-0.00976
					(0.00692)	(0.00693)
Households	4489	4311	5638	4489	4489	4489
PseudoR^2	0.003	0.004	0.008	0.017	0.003	0.018
χ^2	14.943	22.165	50.910	95.478	15.844	96.236

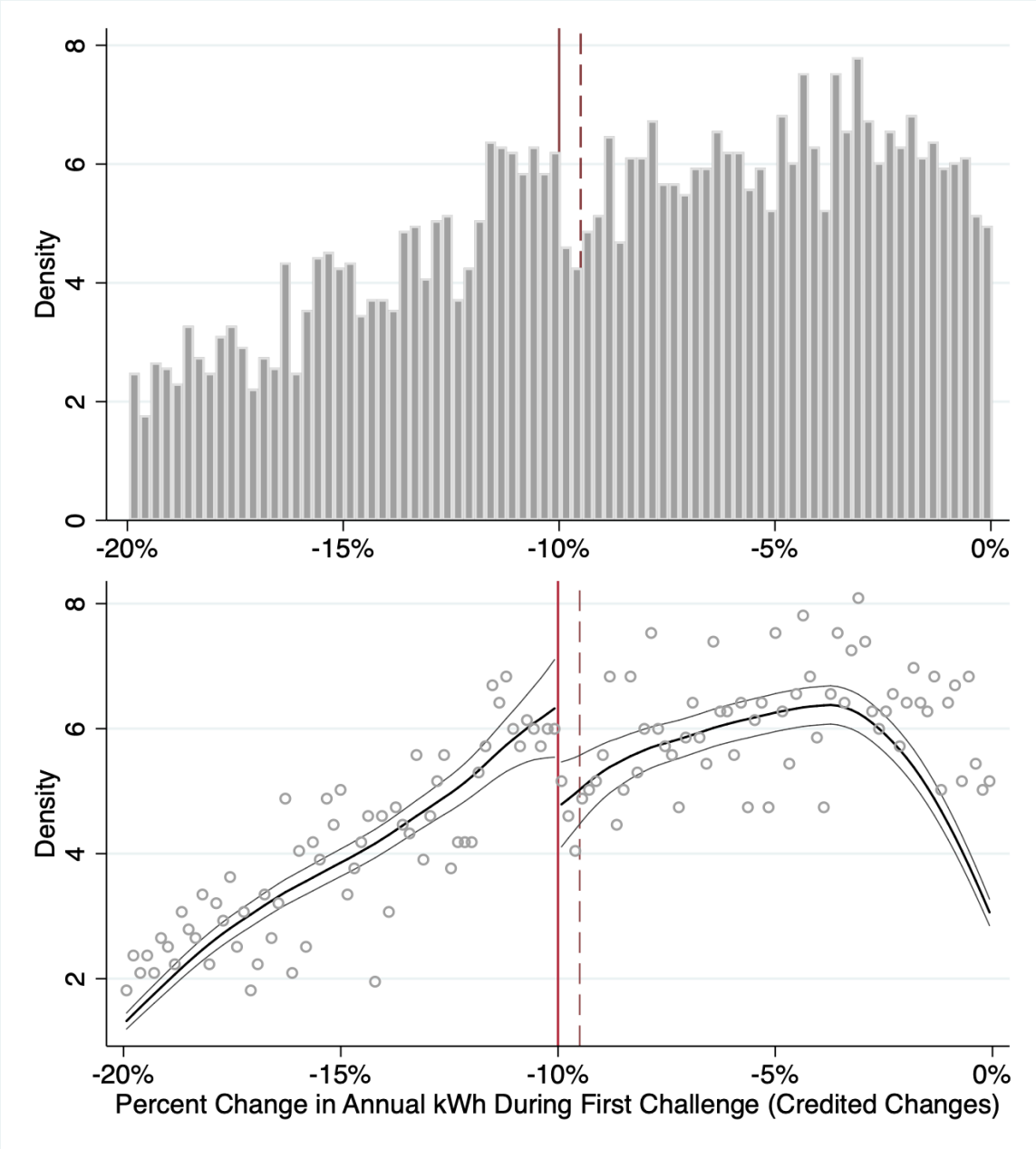
Notes: This table shows how differences in household characteristics are correlated with the probability of re-enrolling in a third conservation challenge. These are estimated using a Probit model with dependent variable an indicator $C_i = 1$ if household i re-enrolls, $C_i = 0$ if household i does not re-enroll. Estimates for specifications (1) - (6) are relative to the reference category of One Story Single Family Dwellings that are primarily non-electric heating. Value and Floor area are natural logs, Credited Changes is the percent change in Challenge 2 electricity conservation credited to households, and Success an indicator equal to 1 if a household achieves their second challenge conservation target. Pre-program use is the number of standard deviations between a household's electricity use in 2006 and the average electricity use among households within the same building and heating type category. All coefficients are marginal effects at the covariate means. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Figure C.1: **Continuity of Covariates at The Discontinuity**



Notes: Averages of four example covariates in the vicinity of the discontinuity by 0.25% wide binds of credited changes. *Electric Heating* is the share of households with electric space heating. *Floor Area* is the average floor space of a household. *Pre-Challenge Use* is the average electricity use in the year before a household begins its first challenge. *Cold Month Before Challenge Start* is the average heating degree days in the last month prior to the initial challenge. This is a measure of the last weather shock prior to the initial participation decision. The x-axis shows reductions in credited use with the dashed red vertical line denoting the 9.5% threshold for success and the solid red vertical line denoting the 10% conservation target.

Figure C.2: **Density Test of the Running Variable**



Notes: The dashed red line is the 9.5% reduction threshold, and the sold line is the 10% reduction target. Histogram of households' credited changes during their initial conservation challenge. The increase in mass to the left of the vertical line demonstrates the potential for bunching at the 10% target. McCrary (2008) density test of the percent change in electricity use from a household's initial conservation challenge. The dark line is a smoothed local linear fit to the density of changes in electricity use, with 95% confidence intervals indicated by the light grey line. Point estimates of the density are grey circles.

Table C.1: **Discontinuity Tests of Covariates**

Dependent Variable:	Window Size				
	3	4	5	6	7
Heating	0.089	0.036	0.022	0.004	0.037
	(0.076)	(0.065)	(0.058)	(0.053)	(0.049)
Floor Area	-168.672	-118.697	-110.062	-61.026	-27.826
	(129.915)	(111.300)	(99.744)	(91.517)	(85.809)
Pre-Program kWh	1155.694	1126.179	673.470	71.468	198.537
	(853.864)	(720.725)	(663.070)	(589.560)	(552.341)
Pre-Program HDD	-23.74	-18.97	-6.499	-4.555	-2.678
	(23.32)	(19.74)	(17.53)	(15.82)	(14.67)
Property Value	-48.510	-30.153	5.379	34.891	54.255
	(68.793)	(62.081)	(54.773)	(51.611)	(47.112)
Share SFD	-0.065	-0.022	-0.042	-0.052	-0.012
	(0.078)	(0.067)	(0.060)	(0.054)	(0.050)

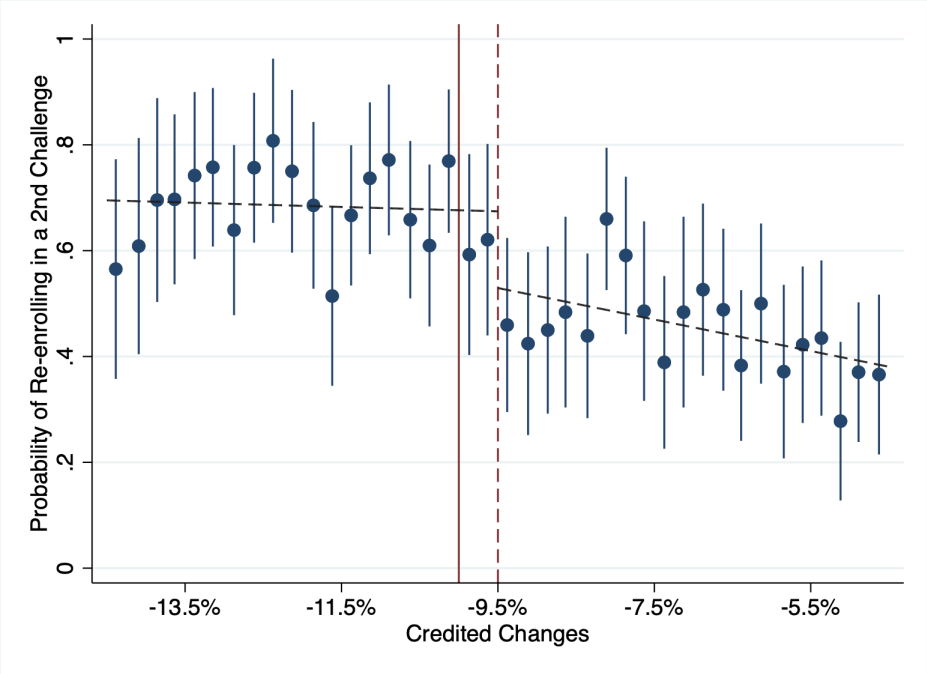
Notes: The table shows regression discontinuity estimates of γ_1 estimated using equation 4 for the listed dependent variables. The lack of statistically significant differences in covariates at the discontinuity supports that treatment is as good as randomly assigned at the discontinuity. Estimates included separate linear trends billed reductions and are not shown for conciseness. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 are listed for completeness but no coefficients are significant at a 10% level.

Figure C.3: **Density Test of the Running Variable - 9.5% Threshold**

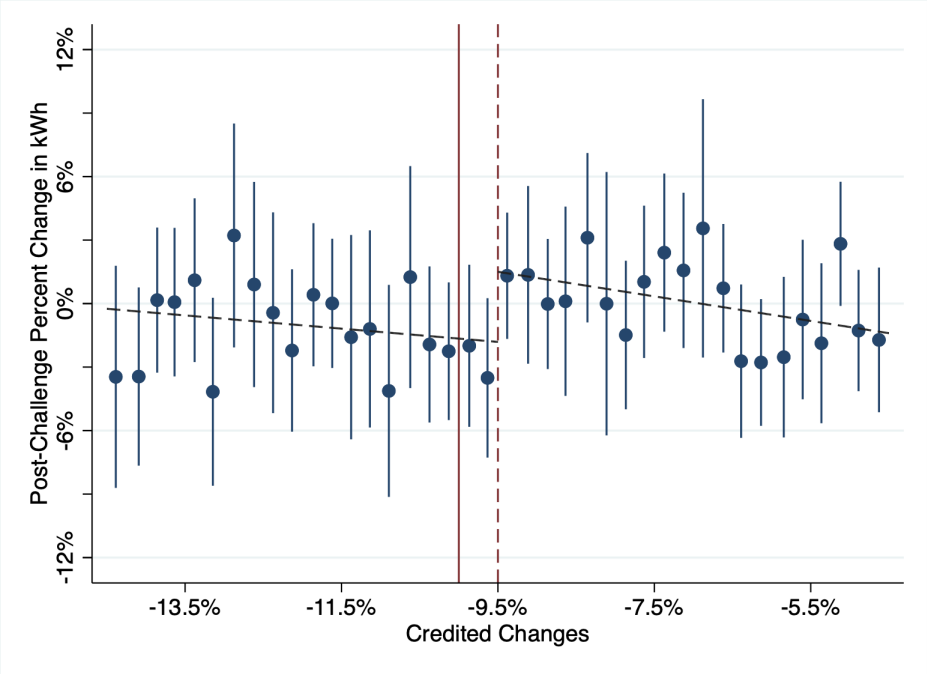
Notes: McCrary (2008) density test of the percent change in electricity use from a household's initial conservation challenge. The dark line is a smoothed local linear fit to the density of changes in electricity use, with 95% confidence intervals indicated by the light grey line. Point estimates of the density are grey circles. The dashed red line is the 9.5% reduction threshold, and the sold line is the 10% reduction target.

Figure C.4: Re-enrollment in a second challenge: first stage and reduced form discontinuities

(a) First stage



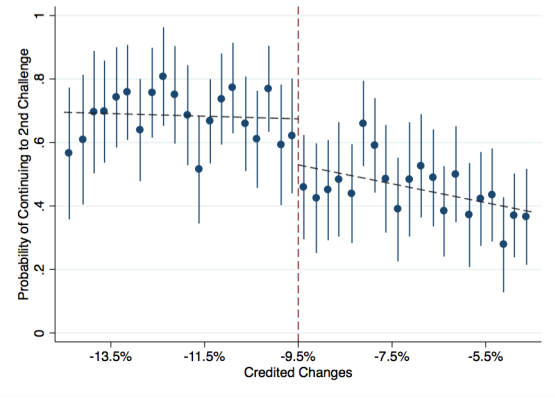
(b) Reduced form



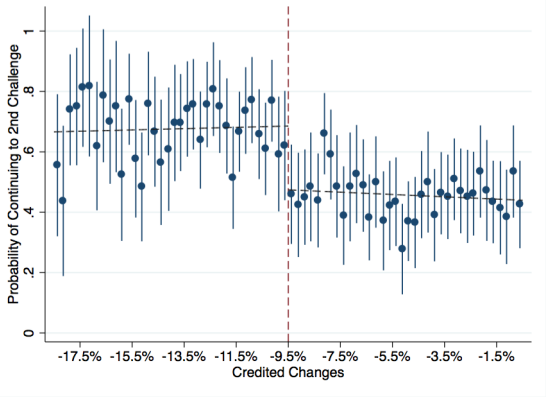
Notes: The sold vertical line is at the 10% conservation target and the dashed vertical line denotes the 9.5% threshold for success in a Challenge. Panel (a) shows the Probability of Re-enrolling as defined in Figure 4. In panel (b) the Post-Challenge Percent Change in kWh denotes the percentage annual change in electricity use from the year of the conservation to the post-challenge year.

Figure C.5: **First Stage and Reduced Form Discontinuities**

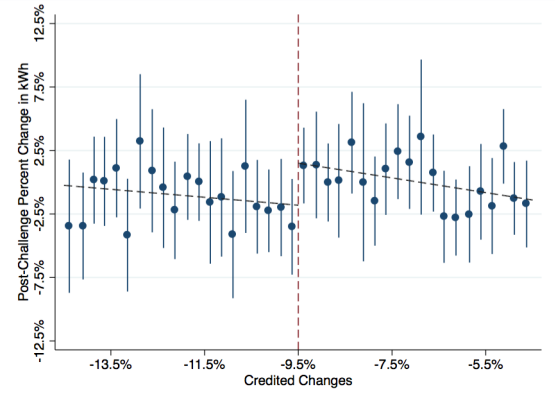
(a) First Stage - ±5% Bandwidth



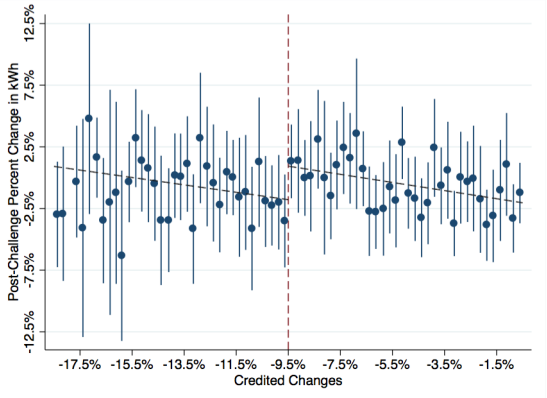
(b) First Stage - ±9% Bandwidth



(c) Reduced Form - ±5% Bandwidth



(d) Reduced Form - ±9% Bandwidth



Notes: This figure plots the first stage and reduced form discontinuities for bandwidths of ±5% and ±9% around the 9.5% reduction threshold in credited changes. Individual point estimates are the average of the outcome variable within 0.25% width bins in credited changes.

Appendix D Fuzzy-Regression Discontinuity Robustness Checks

An identifying assumption of a fuzzy RD estimation strategy is that households just on either side of the discontinuity are as good as randomly assigned. Evidence that this assumption does not hold would be if the IV estimates were sensitive to the inclusion of additional covariates. Table D.1 shows IV estimates controlling for detailed household characteristics and changes in heating degree days. I control for the percent change in heating degree days between both the pre-program and first conservation challenge years ($HDD_{0,1}$) and between the first conservation challenge and post-challenge year ($HDD_{1,2}$). Increases in heating degree days during the post-challenge period are positively correlated with post-challenge changes in electricity use. This is consistent with colder weather increasing the demand for electricity. The inclusion of these additional covariates has only a small effect on the estimated effect of a second conservation challenge and supports the identifying assumption that households are as good as randomly assigned at the discontinuity.

A potential concern with the weather adjustment is if households with the same credited changes differ substantially in billed changes in the vicinity of the discontinuity. If billed reductions affect the post-program outcomes, for example if households were to exhibit a strong reversion to the mean, then outliers in the weather adjustment could cause a violation of the good-as-randomly assigned assumption. Evidence that this is not a problem is gained by further restricting the estimation sample to households that had billed changes within ±5% of 9.5% in billed reductions. This excludes those households receiving large weather adjustments to their billed electricity use, in addition to the estimation bandwidth in credited reductions. Estimates, Table D.2, are robust to this restriction.

A potential concern with RD estimates is that the using observations away from the threshold increases the risk of biased estimates (Calonico et al., 2014). In Table D.3 and Table D.4 I present bias-corrected estimates using 1st and 2nd order polynomial fits and the method of Calonico et al. (2014). Specification (8) presents the optimal bandwidth, 9%, determined using the variance-bias tradeoff method of Calonico et al. (2014). Bias-corrected estimates lose significance for small bandwidths in the 1st order estimates, and in all bandwidths narrower than 9% for 2nd order estimates.

Table D.5 uses an alternate limit to the gap between challenges, limiting the estimation sample to households that re-enroll within 6 months of completing their initial challenge.

D.1 Robustness Checks - Log monthly electricity use

An alternative to defining the outcome in the fuzzy-RD approach as the post-program changes in electricity use, equation (6), is to use log monthly electricity use. This has the benefit of not requiring aggregating to annual changes at the cost of a less transparent estimation. Using log monthly electricity use finds similar estimates as using post-program changes from (6).

The first stage relationship is

Table D.1: **Fuzzy Regression Discontinuity Estimates: Additional Covariates**

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A – First Stage						
Dependent variable: Continue to a Second Challenge C_i						
Window		±7 %	±6 %	±5 %	±4 %	±3 %
γ_1: Success Ind.		0.202	0.188	0.143	0.137	0.169
		(0.0432)	(0.0467)	(0.0515)	(0.0572)	(0.0675)
γ_2: Cred. Reduc.		-0.484	-1.335	-2.834	-0.981	2.186
		(0.800)	(0.995)	(1.268)	(1.781)	(2.774)
γ_3 : Success×		1.130	2.467	2.524	-0.979	-3.635
Cred. Reduc.		(1.108)	(1.385)	(1.807)	(2.437)	(3.892)
γ_4 : Billed Reduc.		-0.329	-0.417	-0.169	-0.475	-0.870
		(0.358)	(0.381)	(0.403)	(0.439)	(0.539)
HD$D_{1,2}$		0.0867	-0.0662	0.142	-0.128	-0.145
		(0.360)	(0.386)	(0.398)	(0.429)	(0.482)
HD$D_{0,1}$		-0.0805	0.0703	-0.00803	0.301	0.591
		(0.351)	(0.375)	(0.384)	(0.410)	(0.463)
γ_0 : Constant		0.462	0.476	0.505	0.483	0.468
		(0.0342)	(0.0372)	(0.0407)	(0.0456)	(0.0531)
F-statistic		21.82	16.27	7.736	5.757	6.266
Panel B – Second Stage						
Dependent variable: Percent change in post-challenge electricity use						
	OLS	Instrumental Variable Estimates				
Window		±7 %	±6 %	±5 %	±4 %	±3 %
β_1 : Re-Enroll	-0.0159	-0.119	-0.168	-0.214	-0.306	-0.176
	(0.00421)	(0.0600)	(0.0726)	(0.113)	(0.157)	(0.112)
β_2: Cred. Reduc.	0.352	0.310	0.297	0.376	0.255	0.299
	(0.0748)	(0.103)	(0.120)	(0.137)	(0.177)	(0.166)
β_3 : Success×	-0.105	-0.142	-0.113	-0.122	0.0475	0.0459
Cred. Reduc.	(0.0698)	(0.0964)	(0.114)	(0.130)	(0.173)	(0.167)
β_4 : Billed Reduc.		-0.323	-0.510	-0.962	-0.853	0.906
		(0.245)	(0.354)	(0.630)	(0.772)	(0.646)
HD$D_{1,2}$		0.320	0.368	0.826	-0.239	-1.543
		(0.308)	(0.421)	(0.601)	(0.956)	(1.207)
HD$D_{0,1}$		-0.142	-0.222	-0.249	-0.418	-0.442
		(0.103)	(0.114)	(0.130)	(0.185)	(0.183)
β_0 : Constant	0.00460	0.0782	0.105	0.138	0.185	0.109
	(0.00447)	(0.0342)	(0.0421)	(0.0656)	(0.0872)	(0.0626)
N	5432	2050	1763	1475	1196	888

Notes: This table reports fuzzy-RD estimates corresponding to equations (4) and (5). All specifications include building type and heating category fixed effects. $HDD_{0,1}$ and $HDD_{1,2}$ are, respectively, the percent change in heating degree days from the pre-program year to the initial challenge, and initial challenge to the post-program year. Estimation sample restricted to households that either start their next challenge within 12 months or do not undertake an additional challenge. Estimation window is restricted to ± the listed percent around the 9.5% threshold in credited changes. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table D.2: **Fuzzy Regression Discontinuity Estimates: Restricted Billing**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A – First Stage							
Dependent variable: Continue to a Second Challenge C_i							
Window			±7 %	±6 %	±5 %	±4 %	±3 %
γ_1: Success Ind.			0.185	0.181	0.121	0.121	0.172
			(0.0485)	(0.0516)	(0.0561)	(0.0614)	(0.0721)
γ_2: Cred. Reduc.			0.124	-0.0825	-2.105	-1.072	3.004
			(1.016)	(1.205)	(1.476)	(2.003)	(3.073)
γ_3 : Success×			-0.697	-0.292	0.0330	-1.981	-5.156
Cred. Reduc.			(1.412)	(1.679)	(2.104)	(2.740)	(4.291)
γ_4 : Billed Reduc.			0.177	0.0615	0.215	0.283	-0.163
			(0.612)	(0.625)	(0.643)	(0.691)	(0.762)
γ_0 : Constant			0.475	0.482	0.515	0.500	0.458
			(0.0349)	(0.0371)	(0.0401)	(0.0444)	(0.0511)
F-stat			14.57	12.34	4.649	3.889	5.665
Panel B – Second Stage							
Dependent variable: Percent change in post-challenge electricity use							
	OLS		Instrumental Variable Estimates				
Window		±5 %	±7 %	±6 %	±5 %	±4 %	±3 %
β_1 : Re-Enroll	-0.0160	-0.0239	-0.171	-0.191	-0.269	-0.307	-0.118
	(0.00422)	(0.00769)	(0.0782)	(0.0848)	(0.159)	(0.188)	(0.103)
β_2: Cred. Reduc.		-0.282	-0.510	-0.638	-1.240	-1.118	0.953
		(0.282)	(0.308)	(0.355)	(0.733)	(0.876)	(0.631)
β_3 : Success×		0.385	-0.153	-0.00562	0.319	-0.386	-1.527
Cred. Reduc.		(0.505)	(0.441)	(0.487)	(0.719)	(1.132)	(1.204)
β_4 : Billed Reduc.		0.192	0.283	0.203	0.238	0.252	0.0407
		(0.172)	(0.190)	(0.194)	(0.238)	(0.279)	(0.212)
β_0 : Constant	-0.00773	0.00903	0.0886	0.102	0.150	0.166	0.0524
	(0.00289)	(0.00817)	(0.0448)	(0.0490)	(0.0916)	(0.106)	(0.0564)
N	5432	1147	1394	1291	1147	982	763

Notes: Sample restricted to households with billed changes within ±5% of the 9.5% conservation target along with restricting households to those within the listed estimation window around the 9.5% threshold in credited reductions. Estimation sample restricted to households that either start their next challenge within 12 months or do not undertake an additional challenge.

Table D.3: **1st Order Bias-Corrected Fuzzy Regression Discontinuity Estimates**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Conventional	-0.187	-0.236	-0.261	-0.239	-0.201	-0.173	-0.164	-0.164
	(0.104)	(0.118)	(0.128)	(0.108)	(0.0858)	(0.0727)	(0.0668)	(0.0669)
Bias-corrected	-0.281	-0.176	-0.194	-0.265	-0.299	-0.293	-0.257	-0.189
	(0.104)	(0.118)	(0.128)	(0.108)	(0.0858)	(0.0727)	(0.0668)	(0.0669)
Robust	-0.281	-0.176	-0.194	-0.265	-0.299	-0.293	-0.257	-0.189
	(0.157)	(0.177)	(0.188)	(0.156)	(0.122)	(0.103)	(0.0936)	(0.0763)
Observations	888	1196	1475	1763	2050	2296	2543	2538
Order Poly. (p)	1	1	1	1	1	1	1	1
Order Bias (q)	2	2	2	2	2	2	2	2
BW Poly. (h)	3%	4%	5%	6%	7%	8%	9%	9%
BW Bias (b)	3%	4%	5%	6%	7%	8%	9%	17%
F-Conv.	6.8	7	7.1	9.2	12.9	16.5	19.4	19.3
F-Bias	6.8	11.2	12.9	10.4	8.9	9.4	12.1	17.7
F-Robust	3.1	4.9	5.5	4.5	3.9	4.1	5.3	13.5

Notes: This table reports fuzzy-RD estimates using the method of (Calonico et al., 2014). All specifications use 1st order local polynomial regressions using a triangular kernel and restricted to households that either start their next challenge within 12 months or do not undertake an additional challenge. Specifications (1) through (7) are for bandwidths BW Poly. (h) around the threshold. Specification (8) determines the optimal polynomial and bias-correction bandwidths to be 9% and 17%, respectively. Conventional, bias-corrected, and bias-corrected and robust F-stats on the 1st stage instrument respectively denoted by F-Conv., F-Bias, and F-Robust. The bias correction is 2nd order, local polynomial. Standard errors in parentheses. Conventional and Bias-corrected have conventional standard errors, Robust estimates use robust standard errors. *** p<0.01, ** p<0.05, * p<0.1.

Table D.4: **2nd Order Bias-Corrected Fuzzy Regression Discontinuity Estimates**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Conventional	-0.281	-0.189	-0.211	-0.264	-0.319	-0.331	-0.281	-0.181
	(0.199)	(0.125)	(0.123)	(0.156)	(0.192)	(0.193)	(0.153)	(0.0794)
Bias-corrected	-0.421	-0.315	-0.207	-0.149	-0.133	-0.216	-0.323	-0.196
	(0.199)	(0.125)	(0.123)	(0.156)	(0.192)	(0.193)	(0.153)	(0.0794)
Robust	-0.421	-0.315	-0.207	-0.149	-0.133	-0.216	-0.323	-0.196
	(0.264)	(0.168)	(0.166)	(0.210)	(0.259)	(0.257)	(0.201)	(0.0848)
Observations	888	1196	1475	1763	2050	2296	2543	4160
OrderPoly.(p)	2	2	2	2	2	2	2	2
OrderBias(q)	3	3	3	3	3	3	3	3
BWPoly.(h)	3%	4%	5%	6%	7%	8%	9%	18%
BWBias(b)	3%	4%	5%	6%	7%	8%	9%	33%
F-Conv.	3.1	4.9	5.5	4.5	3.9	4.1	5.3	14.8
F-Bias	1.4	3.6	6	9.2	9.1	7.3	5.8	14.8
F-Robust	.8	2.1	3.4	5.1	5	4	3.2	13

Notes: All specifications are a 2nd order polynomial estimated with a triangular kernel and restricted to households that either start their next challenge within 12 months or do not undertake an additional challenge. Specifications (1) through (7) are for ± the listed bandwidths around the threshold. Specification (8) determines the optimal polynomial and bias-correction bandwidths to be 18% and 33%, respectively. Conventional, bias-corrected, and bias-corrected and robust F-stats on the 1st stage instrument respectively denoted by F-Conv., F-Bias, and F-Robust. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table D.5: **Fuzzy Regression Discontinuity Estimates: 6 Month Gap**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A – First Stage							
Dependent variable: Continue to a Second Challenge C_i							
Window			±7 %	±6 %	±5 %	±4 %	±3 %
γ_1: Success			0.203	0.195	0.161	0.163	0.170
Indicator			(0.0468)	(0.0505)	(0.0556)	(0.0622)	(0.0727)
γ_2: Cred. Reduc.			-0.775	-1.480	-2.573	-0.510	1.794
			(0.822)	(1.016)	(1.282)	(1.818)	(2.876)
γ_3 : Success×			1.854	3.156	2.909	-0.527	-3.965
Cred. Reduc.			(1.204)	(1.491)	(1.959)	(2.689)	(4.183)
γ_4 : Billed Reduc.			-0.576	-0.678	-0.367	-0.649	-0.867
			(0.344)	(0.367)	(0.391)	(0.433)	(0.520)
γ_0 : Constant			0.435	0.453	0.466	0.440	0.419
			(0.0317)	(0.0344)	(0.0377)	(0.0424)	(0.0495)
F-stat			18.79	14.85	8.374	6.872	5.452
Panel B – Second Stage							
Dependent variable: Percent change in post-challenge electricity use							
	OLS		Instrumental Variable Estimates				
Window		±5 %	±7 %	±6 %	±5 %	±4 %	±3 %
β_1 : Re-Enroll	-0.0171	-0.0246	-0.143	-0.165	-0.190	-0.241	-0.162
	(0.00444)	(0.00718)	(0.0651)	(0.0739)	(0.102)	(0.124)	(0.114)
β_2: Cred. Reduc.		-0.0829	-0.482	-0.580	-0.864	-0.607	0.940
		(0.255)	(0.272)	(0.363)	(0.570)	(0.642)	(0.675)
β_3 : Success×		0.451	0.423	0.544	0.827	-0.126	-1.758
Cred. Reduc.		(0.456)	(0.338)	(0.446)	(0.596)	(0.905)	(1.246)
β_4 : Billed Reduc.		-0.136	-0.120	-0.197	-0.198	-0.325	-0.333
		(0.105)	(0.101)	(0.112)	(0.122)	(0.162)	(0.173)
β_0 : Constant	-0.00773	0.0145	0.0747	0.0879	0.104	0.124	0.0731
	(0.00289)	(0.00793)	(0.0348)	(0.0407)	(0.0554)	(0.0646)	(0.0571)
N	4810	1287	1779	1535	1287	1039	775

Notes: This table reports fuzzy-RD estimates corresponding to equations (4) and (5). Estimation sample restricted to households that either start their next challenge within 6 months or do not undertake an additional challenge. Estimation window is restricted to ± the listed percent around the 9.5% threshold in credited changes. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

$$C_i = \alpha_i + \gamma_0 D_{it,1} + \gamma_1 1\{R_i \leq \bar{R}\} \times D_{it,1} + \gamma_2 R_i \times D_{it,1} + \gamma_3 1\{R_i \leq \bar{R}\} \times R_i \times D_{it,1} + \gamma_4 B_i \times D_{it,1} + \gamma_5 X_i + \eta_{it} \tag{3}$$

where C_i is a binary indicator for whether a household continues to a second challenge, R_i are households' credited changes in electricity use from the first challenge, R_d is the threshold for success in the challenge and is -9.5%, $1\{R_i \leq \bar{R}\}$ is the dummy variable for success in the initial challenge, B_i are the billed changes from the initial challenge, and X_i is a vector of other controls. The instrument excluded from the second stage is $1\{R_i \leq \bar{R}\}$. $D_{it,1}$ is an indicator for if household i in month t was participating in the second challenge. The estimation sample is restricted to only observations for households undertaking their first conservation challenge or in their post-program year of a second challenge or after exiting the program.

The second-stage relationship is

$$y_{it} = \lambda_i + \beta_0 D_{it,1} + \beta_1 C_i + \beta_2 R_i \times D_{it,1} + \beta_3 1\{R_i \leq \bar{R}\} \times R_i \times D_{it,1} + \beta_4 B_i \times D_{it,1} + \beta_5 X_i + \epsilon_i \tag{4}$$

where y_{it} is log monthly electricity use.

Table D.6: **Fuzzy Regression Discontinuity Estimates: Log Monthly Electricity Use and 12 Month Gap**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A – First Stage							
Dependent variable: Continue to a Second Challenge C_i							
Window			±7 %	±6 %	±5 %	±4 %	±3 %
γ_1: Success$_i$			0.197	0.185	0.139	0.138	0.177
			(0.0431)	(0.0467)	(0.0515)	(0.0574)	(0.0679)
γ_0: $D_{it,1}$			0.473	0.477	0.504	0.519	0.503
			(0.0251)	(0.0270)	(0.0297)	(0.0324)	(0.0380)
γ_2: $R_i \times D_{it,1}$			-0.431	-0.721	-2.133	-1.961	0.285
			(0.629)	(0.763)	(0.968)	(1.304)	(2.052)
γ_3 : $1\{R_i \geq \bar{R}\}$			2.268	2.757	1.936	2.066	0.0676
$\times R_i \times D_{it,1}$			(0.687)	(0.875)	(1.133)	(1.477)	(2.315)
γ_4 : $B_i \times D_{it,1}$			-0.288	-0.357	-0.0474	-0.288	-0.527
			(0.323)	(0.345)	(0.367)	(0.402)	(0.488)
F-stat			21.00	15.66	7.302	5.772	6.818
Panel B – Second Stage							
Dependent variable: Log monthly electricity use							
	OLS		Instrumental Variable Estimates				
Window		±5 %	±7 %	±6 %	±5 %	±4 %	±3 %
β_1: Success$_i$	-0.0216	-0.0279	-0.144	-0.184	-0.229	-0.299	-0.146
	(0.00435)	(0.00732)	(0.0679)	(0.0816)	(0.127)	(0.162)	(0.109)
β_0: $D_{it,1}$	-0.0156	-0.00267	0.0647	0.0880	0.115	0.161	0.0747
	(0.00302)	(0.00539)	(0.0388)	(0.0465)	(0.0731)	(0.0953)	(0.0648)
β_2: $R_i \times D_{it,1}$			-0.289	-0.437	-0.773	-1.233	0.00274
			(0.227)	(0.295)	(0.574)	(0.808)	(0.565)
β_3 : $1\{R_i \geq \bar{R}\}$			0.689	0.863	1.414	2.216	2.418
$\times R_i \times D_{it,1}$			(0.278)	(0.349)	(0.435)	(0.591)	(0.814)
β_4 : $B_i \times D_{it,1}$			-0.136	-0.214	-0.214	-0.328	-0.367
			(0.108)	(0.119)	(0.135)	(0.171)	(0.173)
N	130368	35400	49200	42312	35400	28704	21312
Households			2050	1763	1475	1196	888

Notes: Estimates using log monthly electricity use from section D.1. *** p<0.01, ** p<0.05, * p<0.1.

Table D.7: **Fuzzy Regression Discontinuity Estimates: Log Monthly Electricity Use and 6 Month Gap**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A – First Stage							
Dependent variable: Continue to a Second Challenge C_i							
Window			±7 %	±6 %	±5 %	±4 %	±3 %
γ_1: Success$_i$			0.187	0.176	0.154	0.134	0.145
			(0.0391)	(0.0411)	(0.0426)	(0.0470)	(0.0523)
γ_0: $D_{it,1}$			0.420	0.431	0.440	0.445	0.439
			(0.0234)	(0.0245)	(0.0258)	(0.0285)	(0.0318)
γ_2: $R_i \times D_{it,1}$			-0.894	-1.047	-1.264	-1.817	-1.812
			(0.404)	(0.438)	(0.475)	(0.577)	(0.668)
γ_3 : $1\{R_i \geq R_d\}$			2.526	2.557	2.427	2.961	1.370
$\times R_i \times D_{it,1}$			(0.604)	(0.736)	(0.856)	(1.008)	(1.249)
γ_4 : $B_i \times D_{it,1}$			0.185	0.327	0.284	0.638	1.241
			(0.444)	(0.514)	(0.611)	(0.771)	(1.062)
F-stat			22.82	18.25	13.01	8.174	7.657
Panel B – Second Stage							
Dependent variable: Log monthly electricity use							
	OLS		Instrumental Variable Estimates				
Window		±5 %	±7 %	±6 %	±5 %	±4 %	±3 %
β_1: Success$_i$	-0.0223	-0.0281	-0.151	-0.178	-0.219	-0.286	-0.208
	(0.00462)	(0.00768)	(0.0618)	(0.0723)	(0.0920)	(0.130)	(0.115)
β_0: $D_{it,1}$	-0.0156	-0.00267	0.0569	0.0700	0.0884	0.124	0.0836
	(0.00302)	(0.00539)	(0.0316)	(0.0373)	(0.0474)	(0.0663)	(0.0584)
β_2: $R_i \times D_{it,1}$			-0.420	-0.558	-0.720	-0.998	-0.906
			(0.164)	(0.202)	(0.262)	(0.425)	(0.406)
β_3 : $1\{R_i \geq R_d\}$			0.394	0.545	0.748	1.038	1.233
$\times R_i \times D_{it,1}$			(0.228)	(0.259)	(0.309)	(0.459)	(0.328)
β_4 : $B_i \times D_{it,1}$			0.156	0.240	0.389	0.291	0.645
			(0.136)	(0.166)	(0.213)	(0.298)	(0.374)
N	115440	30888	44976	38496	32352	26112	19536
Households			1874	1604	1348	1088	814

Notes: Estimates using log monthly electricity use from section D.1. *** p<0.01, ** p<0.05, * p<0.1.

Appendix E Event Study Estimates For All Households

This section presents the individual monthly point estimates plotted in Figures (1), (B.7), and (2).

Table E.8: Event-Study Point Estimates

	(1)	(2)
	All Households	Participant Households
Dependent Variable: Ln monthly electricity use		
Pre	0.020	0.030
	(0.0051)	(0.010)
M-59	0.027	0.034
	(0.0055)	(0.0097)
M-58	0.032	0.038
	(0.0054)	(0.0093)
M-57	0.024	0.030
	(0.0055)	(0.0090)
M-56	0.024	0.030
	(0.0052)	(0.0087)
M-55	0.016	0.021
	(0.0054)	(0.0087)
M-54	0.019	0.024
	(0.0053)	(0.0086)
M-53	0.017	0.021
	(0.0053)	(0.0087)
M-52	0.020	0.024
	(0.0051)	(0.0086)
M-51	0.022	0.026
	(0.0049)	(0.0084)
M-50	0.024	0.028
	(0.0048)	(0.0082)
M-49	0.026	0.030
	(0.0048)	(0.0079)
M-48	0.029	0.033
	(0.0048)	(0.0076)
M-47	0.027	0.030
	(0.0047)	(0.0072)
M-46	0.026	0.030

Table E.8: Event-Study Point Estimates

	(1)	(2)
	All Households	Participant Households
Dependent Variable: Ln monthly electricity use		
	(0.0045)	(0.0069)
M-45	0.023	0.026
	(0.0045)	(0.0066)
M-44	0.020	0.023
	(0.0044)	(0.0064)
M-43	0.012	0.015
	(0.0045)	(0.0064)
M-42	0.013	0.015
	(0.0045)	(0.0064)
M-41	0.013	0.015
	(0.0045)	(0.0064)
M-40	0.016	0.018
	(0.0043)	(0.0063)
M-39	0.013	0.015
	(0.0043)	(0.0062)
M-38	0.018	0.020
	(0.0041)	(0.0059)
M-37	0.017	0.019
	(0.0041)	(0.0058)
M-36	0.017	0.018
	(0.0041)	(0.0055)
M-35	0.017	0.018
	(0.0041)	(0.0052)
M-34	0.017	0.018
	(0.0040)	(0.0049)
M-33	0.0091	0.010
	(0.0039)	(0.0047)
M-32	0.0054	0.0063
	(0.0038)	(0.0045)
M-31	0.0040	0.0048
	(0.0039)	(0.0045)
M-30	0.0064	0.0069
	(0.0037)	(0.0043)
M-29	0.0071	0.0075
	(0.0035)	(0.0042)
M-28	0.0091	0.0094

Table E.8: Event-Study Point Estimates

	(1)	(2)
	All Households	Participant Households
Dependent Variable: Ln monthly electricity use		
	(0.0035)	(0.0041)
M-27	0.0077	0.0080
	(0.0033)	(0.0039)
M-26	0.0093	0.0095
	(0.0032)	(0.0037)
M-25	0.0061	0.0061
	(0.0031)	(0.0036)
M-24	0.0069	0.0067
	(0.0030)	(0.0033)
M-11	0.0017	0.0013
	(0.0029)	(0.0031)
M-10	0.0024	0.0020
	(0.0029)	(0.0033)
M-9	0.0011	0.00046
	(0.0030)	(0.0035)
M-8	-0.0047	-0.0055
	(0.0031)	(0.0037)
M-7	-0.0031	-0.0041
	(0.0032)	(0.0038)
M-6	-0.0021	-0.0033
	(0.0031)	(0.0038)
M-5	-0.0034	-0.0046
	(0.0031)	(0.0038)
M-4	-0.0047	-0.0060
	(0.0032)	(0.0039)
M-3	-0.011	-0.012
	(0.0032)	(0.0039)
M-2	-0.0080	-0.0093
	(0.0032)	(0.0040)
M-1	-0.017	-0.018
	(0.0034)	(0.0043)
M0	-0.022	-0.023
	(0.0033)	(0.0044)
M1	-0.041	-0.042
	(0.0035)	(0.0049)
M2	-0.049	-0.051

Table E.8: Event-Study Point Estimates

	(1)	(2)
	All Households	Participant Households
Dependent Variable: Ln monthly electricity use		
	(0.0036)	(0.0052)
M3	-0.051	-0.053
	(0.0036)	(0.0054)
M4	-0.052	-0.054
	(0.0035)	(0.0055)
M5	-0.050	-0.052
	(0.0036)	(0.0057)
M6	-0.049	-0.051
	(0.0037)	(0.0058)
M7	-0.048	-0.050
	(0.0036)	(0.0057)
M8	-0.050	-0.052
	(0.0036)	(0.0057)
M9	-0.054	-0.056
	(0.0038)	(0.0059)
M10	-0.049	-0.051
	(0.0038)	(0.0060)
M11	-0.050	-0.052
	(0.0037)	(0.0062)
M12	-0.049	-0.051
	(0.0037)	(0.0065)
M13	-0.053	-0.055
	(0.0038)	(0.0069)
M14	-0.055	-0.057
	(0.0038)	(0.0072)
M15	-0.056	-0.058
	(0.0039)	(0.0075)
M16	-0.057	-0.059
	(0.0039)	(0.0076)
M17	-0.058	-0.060
	(0.0039)	(0.0077)
M18	-0.059	-0.061
	(0.0039)	(0.0078)
M19	-0.060	-0.063
	(0.0039)	(0.0078)
M20	-0.059	-0.061

Table E.8: Event-Study Point Estimates

	(1)	(2)
	All Households	Participant Households
Dependent Variable: Ln monthly electricity use		
	(0.0040)	(0.0079)
M21	-0.061	-0.063
	(0.0041)	(0.0080)
M22	-0.052	-0.055
	(0.0041)	(0.0081)
M23	-0.053	-0.056
	(0.0041)	(0.0084)
M24	-0.050	-0.053
	(0.0042)	(0.0087)
M25	-0.051	-0.054
	(0.0043)	(0.0091)
M26	-0.054	-0.057
	(0.0043)	(0.0094)
M27	-0.053	-0.056
	(0.0043)	(0.0097)
M28	-0.054	-0.057
	(0.0044)	(0.0099)
M29	-0.054	-0.057
	(0.0045)	(0.010)
M30	-0.054	-0.058
	(0.0045)	(0.010)
M31	-0.053	-0.056
	(0.0045)	(0.010)
M32	-0.051	-0.055
	(0.0045)	(0.010)
M33	-0.053	-0.056
	(0.0046)	(0.010)
M34	-0.048	-0.052
	(0.0047)	(0.011)
M35	-0.045	-0.049
	(0.0047)	(0.011)
M36	-0.038	-0.042
	(0.0047)	(0.011)
M37	-0.042	-0.046
	(0.0048)	(0.011)
M38	-0.048	-0.052

Table E.8: Event-Study Point Estimates

	(1)	(2)
	All Households	Participant Households
Dependent Variable: Ln monthly electricity use		
	(0.0048)	(0.012)
M39	-0.046	-0.049
	(0.0048)	(0.012)
M40	-0.045	-0.049
	(0.0049)	(0.012)
M41	-0.046	-0.049
	(0.0049)	(0.012)
M42	-0.049	-0.053
	(0.0050)	(0.012)
M43	-0.048	-0.052
	(0.0050)	(0.012)
M44	-0.048	-0.051
	(0.0051)	(0.013)
M45	-0.048	-0.051
	(0.0052)	(0.013)
M46	-0.043	-0.046
	(0.0052)	(0.013)
M47	-0.041	-0.044
	(0.0052)	(0.013)
M48	-0.037	-0.041
	(0.0052)	(0.013)
M49	-0.039	-0.042
	(0.0053)	(0.014)
M50	-0.043	-0.046
	(0.0053)	(0.014)
M51	-0.046	-0.048
	(0.0055)	(0.014)
M52	-0.046	-0.048
	(0.0054)	(0.014)
M53	-0.042	-0.044
	(0.0055)	(0.015)
M54	-0.045	-0.047
	(0.0056)	(0.015)
M55	-0.045	-0.048
	(0.0058)	(0.015)
M56	-0.043	-0.046

Table E.8: Event-Study Point Estimates

	(1)	(2)
	All Households	Participant Households
Dependent Variable: Ln monthly electricity use		
	(0.0057)	(0.015)
M57	-0.052	-0.055
	(0.0058)	(0.015)
M58	-0.044	-0.047
	(0.0059)	(0.015)
M59	-0.040	-0.043
	(0.0059)	(0.015)
M60	-0.036	-0.039
	(0.0059)	(0.016)
M61	-0.038	-0.040
	(0.0061)	(0.016)
M62	-0.039	-0.040
	(0.0061)	(0.016)
M63	-0.042	-0.044
	(0.0062)	(0.017)
M64	-0.047	-0.048
	(0.0062)	(0.017)
M65	-0.044	-0.045
	(0.0063)	(0.017)
M66	-0.044	-0.044
	(0.0063)	(0.017)
M67	-0.049	-0.050
	(0.0064)	(0.017)
M68	-0.050	-0.050
	(0.0065)	(0.017)
M69	-0.053	-0.054
	(0.0066)	(0.017)
M70	-0.051	-0.051
	(0.0066)	(0.017)
M71	-0.043	-0.043
	(0.0067)	(0.018)
M72	-0.041	-0.041
	(0.0068)	(0.018)
Post	-0.048	-0.045
	(0.0061)	(0.019)
Observations	2243267	1065236

Table E.8: Event-Study Point Estimates

	(1)	(2)
	All Households	Participant Households
Dependent Variable: Ln monthly electricity use		
Households	18694	8877

All specifications include individual and date fixed effects. Specification (1) estimated including both participant and non-participant households. (2) estimated for participant households only. Standard errors are clustered at the household level. *** p<0.01, ** p<0.05, * p<0.1 denote significance levels where 0 is defined as the second year pre-treatment and consists of months M-12 to M-23.

Table E.9: Event-Study Estimates: Selection Into Challenges

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	All	One	Two+	Two	Three+	Three	Four+
Dependent Variable: Ln monthly electricity use							
Pre	0.024	0.020	0.014	0.015	0.012	0.0088	0.015
	(0.0073)	(0.011)	(0.0090)	(0.018)	(0.0100)	(0.016)	(0.012)
M-59	0.035	0.037	0.021	0.039	0.012	0.0034	0.017
	(0.0076)	(0.011)	(0.0097)	(0.019)	(0.011)	(0.017)	(0.014)
M-58	0.037	0.046	0.019	0.031	0.012	0.0091	0.013
	(0.0075)	(0.011)	(0.0098)	(0.020)	(0.011)	(0.017)	(0.014)
M-57	0.028	0.031	0.015	0.033	0.0053	0.017	-0.0014
	(0.0076)	(0.011)	(0.0099)	(0.019)	(0.011)	(0.016)	(0.015)
M-56	0.029	0.025	0.019	0.034	0.011	0.020	0.0066
	(0.0071)	(0.011)	(0.0089)	(0.018)	(0.0100)	(0.015)	(0.013)
M-55	0.021	0.012	0.015	0.034	0.0049	0.0035	0.0057
	(0.0074)	(0.011)	(0.0094)	(0.019)	(0.011)	(0.016)	(0.014)
M-54	0.023	0.016	0.017	0.047	0.0030	-0.0079	0.0087
	(0.0071)	(0.010)	(0.0093)	(0.018)	(0.011)	(0.016)	(0.014)
M-53	0.022	0.016	0.015	0.040	0.0033	-0.0089	0.0096
	(0.0073)	(0.011)	(0.0094)	(0.019)	(0.011)	(0.019)	(0.013)
M-52	0.029	0.030	0.017	0.049	0.0023	-0.0034	0.0051
	(0.0068)	(0.010)	(0.0089)	(0.018)	(0.0099)	(0.017)	(0.012)
M-51	0.031	0.033	0.019	0.054	0.0031	-0.0022	0.0055
	(0.0064)	(0.0097)	(0.0081)	(0.014)	(0.0096)	(0.016)	(0.012)
M-50	0.035	0.039	0.021	0.057	0.0046	-0.0036	0.0083
	(0.0062)	(0.0095)	(0.0080)	(0.014)	(0.0093)	(0.017)	(0.011)
M-49	0.034	0.042	0.018	0.039	0.0076	0.0030	0.0096
	(0.0062)	(0.0098)	(0.0078)	(0.015)	(0.0091)	(0.016)	(0.011)
M-48	0.035	0.037	0.023	0.044	0.012	0.015	0.010
	(0.0062)	(0.0094)	(0.0080)	(0.016)	(0.0091)	(0.015)	(0.011)

Table E.9: Event-Study Estimates: Selection Into Challenges

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	All	One	Two+	Two	Three+	Three	Four+
Dependent Variable: Ln monthly electricity use							
M-47	0.025	0.021	0.018	0.030	0.010	0.012	0.0092
	(0.0064)	(0.010)	(0.0080)	(0.016)	(0.0090)	(0.016)	(0.010)
M-46	0.024	0.018	0.018	0.038	0.0078	0.0046	0.0086
	(0.0060)	(0.0092)	(0.0078)	(0.015)	(0.0089)	(0.016)	(0.010)
M-45	0.025	0.021	0.018	0.047	0.0042	0.012	-0.000069
	(0.0060)	(0.0090)	(0.0077)	(0.015)	(0.0090)	(0.016)	(0.011)
M-44	0.021	0.021	0.011	0.031	0.0016	0.021	-0.0080
	(0.0058)	(0.0086)	(0.0076)	(0.015)	(0.0086)	(0.015)	(0.011)
M-43	0.014	0.0048	0.0100	0.031	-0.000074	0.0058	-0.0033
	(0.0059)	(0.0089)	(0.0078)	(0.016)	(0.0086)	(0.015)	(0.010)
M-42	0.017	0.0030	0.017	0.042	0.0052	0.020	-0.0021
	(0.0059)	(0.0092)	(0.0075)	(0.014)	(0.0088)	(0.015)	(0.011)
M-41	0.017	0.0065	0.015	0.046	0.00034	0.021	-0.0096
	(0.0058)	(0.0092)	(0.0074)	(0.015)	(0.0085)	(0.015)	(0.010)
M-40	0.022	0.019	0.014	0.044	0.00029	0.012	-0.0055
	(0.0055)	(0.0085)	(0.0071)	(0.014)	(0.0081)	(0.014)	(0.0097)
M-39	0.016	0.019	0.0052	0.025	-0.0046	0.0055	-0.0098
	(0.0056)	(0.0087)	(0.0073)	(0.015)	(0.0083)	(0.014)	(0.010)
M-38	0.023	0.024	0.014	0.036	0.0029	0.0034	0.0021
	(0.0053)	(0.0084)	(0.0068)	(0.014)	(0.0077)	(0.013)	(0.0092)
M-37	0.023	0.025	0.013	0.036	0.0028	-0.0070	0.0066
	(0.0054)	(0.0082)	(0.0071)	(0.013)	(0.0084)	(0.016)	(0.0097)
M-36	0.019	0.018	0.012	0.029	0.0026	-0.0033	0.0046
	(0.0054)	(0.0082)	(0.0071)	(0.013)	(0.0084)	(0.015)	(0.010)
M-35	0.017	0.021	0.0072	0.014	0.0023	-0.0010	0.0032
	(0.0054)	(0.0079)	(0.0071)	(0.013)	(0.0084)	(0.016)	(0.0097)
M-34	0.015	0.015	0.0070	0.014	0.0021	0.0040	0.00062
	(0.0053)	(0.0082)	(0.0068)	(0.013)	(0.0079)	(0.013)	(0.0097)
M-33	0.0058	0.0088	-0.0029	0.0099	-0.0096	-0.0058	-0.012
	(0.0051)	(0.0079)	(0.0066)	(0.013)	(0.0076)	(0.013)	(0.0094)
M-32	0.0014	0.0061	-0.0082	-0.0030	-0.012	0.00071	-0.018
	(0.0049)	(0.0072)	(0.0067)	(0.014)	(0.0075)	(0.013)	(0.0092)
M-31	0.0014	-0.00049	-0.0027	0.0085	-0.0084	0.0037	-0.014
	(0.0051)	(0.0074)	(0.0070)	(0.012)	(0.0084)	(0.012)	(0.011)
M-30	0.0049	0.0033	0.00085	0.0077	-0.0030	0.00041	-0.0051
	(0.0047)	(0.0072)	(0.0063)	(0.012)	(0.0072)	(0.013)	(0.0085)

Table E.9: Event-Study Estimates: Selection Into Challenges

	(1) All	(2) One	(3) Two+	(4) Two	(5) Three+	(6) Three	(7) Four+
Dependent Variable: Ln monthly electricity use							
M-29	0.0061	0.0094	-0.0014	0.0057	-0.0053	-0.000065	-0.0082
	(0.0046)	(0.0067)	(0.0062)	(0.013)	(0.0070)	(0.013)	(0.0084)
M-28	0.011	0.016	0.0017	0.014	-0.0040	0.0029	-0.0075
	(0.0044)	(0.0065)	(0.0059)	(0.012)	(0.0067)	(0.012)	(0.0082)
M-27	0.0065	0.0081	0.0014	0.011	-0.0030	0.0028	-0.0060
	(0.0042)	(0.0065)	(0.0055)	(0.010)	(0.0064)	(0.011)	(0.0079)
M-26	0.0082	0.013	0.0011	0.0067	-0.0018	-0.0048	-0.0010
	(0.0041)	(0.0064)	(0.0053)	(0.010)	(0.0062)	(0.011)	(0.0075)
M-25	0.0054	0.010	-0.0020	0.0032	-0.0048	-0.0079	-0.0038
	(0.0040)	(0.0060)	(0.0054)	(0.010)	(0.0064)	(0.010)	(0.0079)
M-24	0.0060	0.0069	0.0025	0.0093	-0.00068	-0.0039	0.00053
	(0.0039)	(0.0056)	(0.0054)	(0.010)	(0.0063)	(0.010)	(0.0078)
M-11	0.0045	0.0042	0.0063	0.012	0.0046	-0.00089	0.0069
	(0.0035)	(0.0049)	(0.0048)	(0.0095)	(0.0056)	(0.010)	(0.0067)
M-10	0.0045	0.0031	0.0073	0.014	0.0050	0.0058	0.0047
	(0.0036)	(0.0050)	(0.0051)	(0.0093)	(0.0061)	(0.0095)	(0.0076)
M-9	0.0011	0.00014	0.0036	0.0090	0.0017	0.0065	-0.00016
	(0.0037)	(0.0052)	(0.0053)	(0.010)	(0.0061)	(0.011)	(0.0074)
M-8	-0.0048	-0.0086	0.00041	0.0058	-0.0014	0.0051	-0.0039
	(0.0040)	(0.0058)	(0.0055)	(0.011)	(0.0063)	(0.011)	(0.0078)
M-7	-0.0013	-0.0018	0.00086	0.0027	0.00057	0.0047	-0.00081
	(0.0040)	(0.0055)	(0.0058)	(0.012)	(0.0066)	(0.011)	(0.0080)
M-6	0.00059	0.0016	0.0012	-0.0083	0.0057	0.0100	0.0043
	(0.0040)	(0.0054)	(0.0059)	(0.012)	(0.0066)	(0.011)	(0.0081)
M-5	0.00023	0.0021	0.00017	-0.0034	0.0022	0.0054	0.0012
	(0.0040)	(0.0054)	(0.0059)	(0.012)	(0.0068)	(0.011)	(0.0084)
M-4	-0.0033	-0.0029	-0.0018	0.0055	-0.0044	-0.014	-0.000036
	(0.0040)	(0.0056)	(0.0056)	(0.011)	(0.0065)	(0.012)	(0.0077)
M-3	-0.0087	-0.0054	-0.010	0.0054	-0.016	-0.035	-0.0080
	(0.0041)	(0.0057)	(0.0058)	(0.012)	(0.0067)	(0.013)	(0.0077)
M-2	-0.0039	0.0017	-0.0076	-0.0039	-0.0087	-0.025	-0.0021
	(0.0040)	(0.0055)	(0.0057)	(0.011)	(0.0064)	(0.012)	(0.0076)
M-1	-0.012	-0.0010	-0.020	-0.028	-0.017	-0.038	-0.0080
	(0.0042)	(0.0058)	(0.0060)	(0.011)	(0.0072)	(0.012)	(0.0088)
M0	-0.015	0.0019	-0.029	-0.028	-0.029	-0.047	-0.021
	(0.0041)	(0.0058)	(0.0058)	(0.011)	(0.0067)	(0.012)	(0.0081)

Table E.9: Event-Study Estimates: Selection Into Challenges

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	All	One	Two+	Two	Three+	Three	Four+
Dependent Variable: Ln monthly electricity use							
M1	-0.029	-0.0069	-0.049	-0.043	-0.051	-0.074	-0.042
	(0.0044)	(0.0062)	(0.0060)	(0.011)	(0.0069)	(0.013)	(0.0080)
M2	-0.035	-0.012	-0.056	-0.047	-0.059	-0.077	-0.052
	(0.0043)	(0.0061)	(0.0059)	(0.011)	(0.0069)	(0.012)	(0.0082)
M3	-0.039	-0.014	-0.062	-0.054	-0.064	-0.071	-0.062
	(0.0044)	(0.0061)	(0.0060)	(0.011)	(0.0072)	(0.013)	(0.0085)
M4	-0.043	-0.016	-0.067	-0.056	-0.071	-0.069	-0.072
	(0.0043)	(0.0060)	(0.0059)	(0.010)	(0.0070)	(0.013)	(0.0083)
M5	-0.039	-0.012	-0.063	-0.052	-0.068	-0.070	-0.066
	(0.0045)	(0.0061)	(0.0063)	(0.011)	(0.0074)	(0.013)	(0.0088)
M6	-0.037	-0.0100	-0.061	-0.064	-0.060	-0.073	-0.054
	(0.0046)	(0.0060)	(0.0067)	(0.013)	(0.0075)	(0.015)	(0.0086)
M7	-0.035	-0.0056	-0.062	-0.059	-0.062	-0.071	-0.059
	(0.0045)	(0.0062)	(0.0062)	(0.011)	(0.0073)	(0.013)	(0.0086)
M8	-0.038	-0.0043	-0.068	-0.060	-0.072	-0.079	-0.069
	(0.0045)	(0.0064)	(0.0061)	(0.011)	(0.0071)	(0.013)	(0.0084)
M9	-0.045	-0.011	-0.077	-0.061	-0.083	-0.089	-0.081
	(0.0048)	(0.0069)	(0.0063)	(0.012)	(0.0073)	(0.014)	(0.0085)
M10	-0.039	-0.0032	-0.073	-0.062	-0.077	-0.082	-0.075
	(0.0048)	(0.0066)	(0.0066)	(0.013)	(0.0076)	(0.013)	(0.0091)
M11	-0.040	-0.0026	-0.074	-0.062	-0.079	-0.089	-0.075
	(0.0046)	(0.0063)	(0.0064)	(0.012)	(0.0075)	(0.014)	(0.0089)
M12	-0.038	0.00075	-0.073	-0.049	-0.083	-0.086	-0.082
	(0.0046)	(0.0062)	(0.0065)	(0.012)	(0.0075)	(0.014)	(0.0088)
Gap 1	-0.053	0	-0.076	-0.061	-0.081	-0.073	-0.084
	(0.0056)	(.)	(0.0062)	(0.011)	(0.0073)	(0.013)	(0.0087)
M13	-0.050	-0.0084	-0.089	-0.059	-0.10	-0.094	-0.10
	(0.0048)	(0.0065)	(0.0066)	(0.012)	(0.0077)	(0.014)	(0.0090)
M14	-0.053	-0.013	-0.090	-0.053	-0.11	-0.100	-0.11
	(0.0050)	(0.0067)	(0.0069)	(0.014)	(0.0079)	(0.014)	(0.0094)
M15	-0.049	-0.0076	-0.088	-0.037	-0.11	-0.10	-0.11
	(0.0050)	(0.0066)	(0.0070)	(0.013)	(0.0082)	(0.015)	(0.0095)
M16	-0.047	-0.0076	-0.085	-0.036	-0.11	-0.096	-0.11
	(0.0049)	(0.0065)	(0.0069)	(0.013)	(0.0080)	(0.015)	(0.0094)
M17	-0.044	-0.0081	-0.077	-0.032	-0.097	-0.092	-0.099
	(0.0049)	(0.0066)	(0.0069)	(0.013)	(0.0078)	(0.014)	(0.0092)

Table E.9: Event-Study Estimates: Selection Into Challenges

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	All	One	Two+	Two	Three+	Three	Four+
Dependent Variable: Ln monthly electricity use							
M18	-0.048	-0.013	-0.081	-0.043	-0.096	-0.089	-0.099
	(0.0050)	(0.0067)	(0.0071)	(0.014)	(0.0081)	(0.014)	(0.0096)
M19	-0.049	-0.012	-0.083	-0.042	-0.10	-0.10	-0.10
	(0.0051)	(0.0067)	(0.0072)	(0.013)	(0.0084)	(0.015)	(0.0099)
M20	-0.050	-0.012	-0.086	-0.046	-0.10	-0.10	-0.10
	(0.0051)	(0.0069)	(0.0070)	(0.013)	(0.0081)	(0.015)	(0.0096)
M21	-0.053	-0.011	-0.093	-0.060	-0.11	-0.095	-0.11
	(0.0052)	(0.0068)	(0.0073)	(0.015)	(0.0082)	(0.014)	(0.0098)
M22	-0.043	0.0025	-0.086	-0.055	-0.100	-0.088	-0.10
	(0.0052)	(0.0067)	(0.0073)	(0.015)	(0.0081)	(0.015)	(0.0096)
M23	-0.044	-0.0013	-0.084	-0.038	-0.10	-0.090	-0.11
	(0.0052)	(0.0068)	(0.0073)	(0.014)	(0.0085)	(0.015)	(0.010)
M24	-0.040	0.0016	-0.080	-0.018	-0.11	-0.095	-0.11
	(0.0052)	(0.0069)	(0.0073)	(0.013)	(0.0085)	(0.016)	(0.0099)
Gap 2	-0.062	0	-0.085	0	-0.099	-0.083	-0.11
	(0.0082)	(.)	(0.0088)	(.)	(0.0092)	(0.017)	(0.011)
M25	-0.042	0.00020	-0.083	-0.022	-0.11	-0.078	-0.12
	(0.0052)	(0.0069)	(0.0073)	(0.013)	(0.0085)	(0.015)	(0.010)
M26	-0.045	-0.0016	-0.086	-0.020	-0.11	-0.088	-0.13
	(0.0052)	(0.0068)	(0.0074)	(0.013)	(0.0086)	(0.015)	(0.010)
M27	-0.042	0.00018	-0.082	-0.0093	-0.11	-0.081	-0.13
	(0.0053)	(0.0069)	(0.0074)	(0.013)	(0.0086)	(0.014)	(0.010)
M28	-0.041	-0.00085	-0.080	-0.0071	-0.11	-0.073	-0.13
	(0.0053)	(0.0069)	(0.0074)	(0.014)	(0.0085)	(0.015)	(0.010)
M29	-0.040	-0.000075	-0.078	-0.0094	-0.11	-0.074	-0.12
	(0.0054)	(0.0071)	(0.0076)	(0.014)	(0.0086)	(0.015)	(0.010)
M30	-0.042	-0.0052	-0.078	-0.016	-0.10	-0.075	-0.12
	(0.0055)	(0.0073)	(0.0076)	(0.014)	(0.0087)	(0.016)	(0.010)
M31	-0.044	-0.0029	-0.084	-0.016	-0.11	-0.076	-0.13
	(0.0056)	(0.0072)	(0.0079)	(0.014)	(0.0093)	(0.017)	(0.011)
M32	-0.040	0.0021	-0.082	-0.028	-0.11	-0.070	-0.12
	(0.0055)	(0.0072)	(0.0077)	(0.014)	(0.0091)	(0.017)	(0.011)
M33	-0.042	0.0020	-0.085	-0.034	-0.11	-0.058	-0.13
	(0.0057)	(0.0075)	(0.0078)	(0.014)	(0.0091)	(0.017)	(0.011)
M34	-0.038	0.0054	-0.082	-0.023	-0.11	-0.044	-0.13
	(0.0056)	(0.0073)	(0.0079)	(0.014)	(0.0091)	(0.016)	(0.011)

Table E.9: Event-Study Estimates: Selection Into Challenges

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	All	One	Two+	Two	Three+	Three	Four+
Dependent Variable: Ln monthly electricity use							
M35	-0.036	0.0090	-0.082	-0.012	-0.11	-0.051	-0.13
	(0.0056)	(0.0072)	(0.0079)	(0.015)	(0.0092)	(0.017)	(0.011)
M36	-0.030	0.018	-0.080	-0.0027	-0.11	-0.051	-0.13
	(0.0057)	(0.0073)	(0.0081)	(0.014)	(0.0095)	(0.017)	(0.011)
Gap 3	-0.050	0	-0.076	0	-0.091	0	-0.098
	(0.010)	(.)	(0.011)	(.)	(0.012)	(.)	(0.012)
M37	-0.034	0.0092	-0.080	-0.0017	-0.11	-0.037	-0.14
	(0.0058)	(0.0075)	(0.0083)	(0.014)	(0.0097)	(0.017)	(0.011)
M38	-0.038	0.0060	-0.084	0.0052	-0.12	-0.045	-0.15
	(0.0060)	(0.0074)	(0.0086)	(0.015)	(0.010)	(0.017)	(0.012)
M39	-0.037	0.0094	-0.086	-0.00075	-0.12	-0.047	-0.15
	(0.0059)	(0.0074)	(0.0084)	(0.015)	(0.0098)	(0.016)	(0.012)
M40	-0.034	0.0086	-0.079	0.00053	-0.11	-0.053	-0.13
	(0.0060)	(0.0075)	(0.0086)	(0.015)	(0.010)	(0.018)	(0.012)
M41	-0.033	0.011	-0.080	-0.012	-0.11	-0.051	-0.13
	(0.0061)	(0.0076)	(0.0088)	(0.016)	(0.010)	(0.018)	(0.012)
M42	-0.033	0.0073	-0.077	-0.011	-0.11	-0.041	-0.13
	(0.0061)	(0.0077)	(0.0088)	(0.015)	(0.010)	(0.019)	(0.012)
M43	-0.032	0.0065	-0.074	-0.0091	-0.10	-0.038	-0.12
	(0.0061)	(0.0077)	(0.0088)	(0.014)	(0.011)	(0.020)	(0.012)
M44	-0.031	0.0100	-0.076	-0.015	-0.10	-0.031	-0.13
	(0.0062)	(0.0077)	(0.0090)	(0.016)	(0.011)	(0.020)	(0.012)
M45	-0.030	0.011	-0.076	-0.012	-0.11	-0.023	-0.13
	(0.0063)	(0.0077)	(0.0093)	(0.016)	(0.011)	(0.020)	(0.013)
M46	-0.027	0.015	-0.076	-0.017	-0.10	-0.024	-0.13
	(0.0063)	(0.0079)	(0.0092)	(0.016)	(0.011)	(0.020)	(0.013)
M47	-0.028	0.015	-0.078	-0.017	-0.11	-0.048	-0.12
	(0.0064)	(0.0080)	(0.0093)	(0.017)	(0.011)	(0.021)	(0.012)
M48	-0.024	0.018	-0.074	-0.0039	-0.11	-0.059	-0.12
	(0.0065)	(0.0080)	(0.0096)	(0.016)	(0.011)	(0.024)	(0.013)
Gap 4	-0.050	0	-0.080	0	-0.097	0	-0.11
	(0.015)	(.)	(0.016)	(.)	(0.016)	(.)	(0.017)
M49	-0.029	0.012	-0.077	-0.0028	-0.11	-0.068	-0.13
	(0.0065)	(0.0080)	(0.0094)	(0.016)	(0.011)	(0.022)	(0.013)
M50	-0.028	0.011	-0.076	-0.0069	-0.11	-0.061	-0.12
	(0.0066)	(0.0082)	(0.0097)	(0.016)	(0.011)	(0.019)	(0.013)

Table E.9: Event-Study Estimates: Selection Into Challenges

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	All	One	Two+	Two	Three+	Three	Four+
Dependent Variable: Ln monthly electricity use							
M51	-0.024	0.012	-0.069	0.00069	-0.10	-0.059	-0.12
	(0.0067)	(0.0083)	(0.0097)	(0.016)	(0.012)	(0.020)	(0.014)
M52	-0.025	0.011	-0.072	-0.0011	-0.11	-0.057	-0.12
	(0.0067)	(0.0083)	(0.0098)	(0.016)	(0.012)	(0.020)	(0.014)
M53	-0.025	0.014	-0.076	-0.029	-0.100	-0.038	-0.12
	(0.0072)	(0.0084)	(0.011)	(0.022)	(0.013)	(0.020)	(0.015)
M54	-0.024	0.016	-0.077	-0.022	-0.10	-0.055	-0.12
	(0.0070)	(0.0083)	(0.011)	(0.017)	(0.014)	(0.027)	(0.015)
M55	-0.026	0.017	-0.082	-0.027	-0.11	-0.029	-0.13
	(0.0071)	(0.0085)	(0.011)	(0.018)	(0.013)	(0.023)	(0.016)
M56	-0.028	0.014	-0.083	-0.032	-0.11	-0.022	-0.13
	(0.0073)	(0.0088)	(0.011)	(0.019)	(0.014)	(0.025)	(0.016)
M57	-0.031	0.0070	-0.082	-0.040	-0.10	-0.031	-0.13
	(0.0074)	(0.0089)	(0.012)	(0.020)	(0.014)	(0.026)	(0.016)
M58	-0.029	0.010	-0.083	-0.033	-0.11	-0.052	-0.13
	(0.0076)	(0.0090)	(0.012)	(0.020)	(0.015)	(0.032)	(0.016)
M59	-0.032	0.0085	-0.087	-0.025	-0.12	-0.065	-0.13
	(0.0075)	(0.0088)	(0.012)	(0.019)	(0.015)	(0.038)	(0.016)
M60	-0.025	0.017	-0.085	-0.013	-0.12	-0.079	-0.14
	(0.0076)	(0.0089)	(0.012)	(0.019)	(0.015)	(0.038)	(0.016)
Gap 5	-0.050	0	-0.083	0	-0.10	0	-0.11
	(0.018)	(.)	(0.019)	(.)	(0.019)	(.)	(0.020)
M61	-0.023	0.016	-0.077	0.0083	-0.12	-0.046	-0.15
	(0.0076)	(0.0091)	(0.012)	(0.019)	(0.015)	(0.027)	(0.017)
M62	-0.022	0.016	-0.078	0.0015	-0.12	-0.041	-0.14
	(0.0077)	(0.0091)	(0.012)	(0.019)	(0.015)	(0.029)	(0.017)
M63	-0.024	0.014	-0.079	0.0042	-0.12	-0.032	-0.15
	(0.0077)	(0.0092)	(0.012)	(0.019)	(0.015)	(0.028)	(0.018)
M64	-0.026	0.011	-0.081	0.0036	-0.13	-0.046	-0.15
	(0.0079)	(0.0094)	(0.013)	(0.019)	(0.016)	(0.031)	(0.018)
M65	-0.024	0.011	-0.077	0.014	-0.13	-0.032	-0.16
	(0.0080)	(0.0094)	(0.013)	(0.018)	(0.016)	(0.027)	(0.019)
M66	-0.021	0.011	-0.068	-0.00079	-0.11	-0.021	-0.13
	(0.0080)	(0.0094)	(0.013)	(0.019)	(0.016)	(0.028)	(0.019)
M67	-0.020	0.0065	-0.057	0.011	-0.093	-0.0025	-0.12
	(0.0082)	(0.0098)	(0.013)	(0.019)	(0.016)	(0.027)	(0.019)

Table E.9: Event-Study Estimates: Selection Into Challenges

	(1) All	(2) One	(3) Two+	(4) Two	(5) Three+	(6) Three	(7) Four+
Dependent Variable: Ln monthly electricity use							
M68	-0.022	0.0080	-0.066	0.0019	-0.10	-0.017	-0.13
	(0.0082)	(0.0097)	(0.013)	(0.019)	(0.017)	(0.032)	(0.019)
M69	-0.024	0.0033	-0.062	-0.0059	-0.093	-0.028	-0.12
	(0.0086)	(0.010)	(0.014)	(0.021)	(0.018)	(0.033)	(0.020)
M70	-0.024	0.0064	-0.070	-0.020	-0.097	-0.057	-0.11
	(0.0085)	(0.010)	(0.014)	(0.021)	(0.018)	(0.030)	(0.021)
M71	-0.022	0.012	-0.076	-0.0046	-0.12	-0.064	-0.14
	(0.0085)	(0.0100)	(0.014)	(0.019)	(0.019)	(0.030)	(0.023)
M72	-0.027	0.0089	-0.086	-0.016	-0.13	-0.079	-0.15
	(0.0085)	(0.0100)	(0.014)	(0.019)	(0.018)	(0.034)	(0.021)
Post	-0.020	0.0072	-0.064	-0.0087	-0.10	-0.053	-0.12
	(0.0077)	(0.0087)	(0.013)	(0.018)	(0.017)	(0.030)	(0.019)
Observations	1513669	1184992	1190510	958670	1093673	928673	1026833

All specifications include individual and date fixed effects, participant and non-participant households, and are restricted to participant households that begin their subsequent challenges within 12 months of finishing their previous challenge. In addition, specifications have the following restrictions: (1) has no further restrictions; (2) is households that undertake a single challenge only; (3) is households that undertake two or more challenges; (4) households that undertake two challenges only; (5) households undertaking three or more challenges; (6) three challenges only; (7) Four or more challenges. Standard errors are clustered at the household level. *** p<0.01, ** p<0.05, * p<0.1 denote significance levels where 0 is defined as the second year pre-treatment and consists of months M-12 to M-23.

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