BEHAVIOR MODIFICATION REPORT WITH PEAK REDUCTION COMPONENT

PRESENTATION TO THE TECHNICAL SUB-COMMITTEE OF THE ENERGY WASTE REDUCTION COLLABORATIVE

DEREK KIRCHNER, DTE ENERGY

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Behavior Modification Report with Peak Reduction Component

The behavior modification report with a peak reduction component delivers periodic energy consumption reports with targeted notifications regarding peak demand.

- Behavior modification reports provide residential households accurate and timely information on their energy consumption through a variety of communication methods to change the consumers' energy usage behavior.
- The peak reduction component provides report recipients with additional messaging targeting energy consumption during specific hours on specific days.
- Table 1, below, describes the behavior modification report with and without the peak reduction component.

Table 1. Measure Description

Behavior Modification Report	With Peak Reduction Component
• Delivers periodic energy consumption reports • Comparison of the customer's home energy use compared to neighbors' energy usage • An energy consumption grade • A simple opt-out process • Comparison of the current period's energy usage with a past period's use and comments on increased or decreased energy utilization[1] • Suggested actions the customer can take to improve energy efficiency including some low or no cost ideas, as well as higher impact ideas that may require capital expenses	• Delivers targeted notifications • Pre-peak day event notification including suggestions on how to reduce energy during a peak event • A post event summary on energy reduction efforts • A simple opt-out process • Comparison of current peak demand with past peak demand and commentary on increased or decreased utilization[2] • Suggested actions the customer can take to improve peak demand reductions including some low or no cost ideas, as well as higher impact ideas that may require capital expenses

[1]Typically, this compares the current month or quarter with the same month or quarter from the prior year, adjusted for climate
[2]Typically, this compares the current day with the same weekday from the previous 10 days, adjusted for climate

DTE Energy implemented a pilot program in 2016 targeting behavior modification report recipients to measure the total savings associated with a behavior modification report with a peak reduction component.

- DTE Energy implemented a pilot program in 2016 in which peak reduction messaging was delivered to behavior modification report recipients. Specifically, participants in the Home Energy Report (HER) program, implemented by Oracle, was targeted.
- The pilot was designed as a Randomized Control Trial, the "gold" standard and preferred methodology for evaluating savings from a behavioral program.[1]
- Table 2 identifies the dates during which pilot participants received additional messaging targeting peak demand during 3 to 6 PM.

Table 2. 2016 Peak Reduction Events

Event	2016
1	7/6/2016
2	7/22/2016
3	7/27/2016
4	8/4/2016
5	8/5/2016
6	8/10/2016
7	8/11/2016
8	8/19/2016
9	8/30/2016
10	9/7/2016

[1]See, for example, State and Local Energy Efficiency Action Network. 2012. "Evaluation, Measurement, and Verification (EM&V) of Residential Behavior-Based Energy Efficiency Programs: Issues and Recommendations." Prepared by A. Todd, E. Stuart, S. Schiller, and C. Goldman, Lawrence Berkeley National Laboratory. http://behavioranalytics.lbl.gov.

Navigant used regression analysis to estimate coincident peak demand and electric energy savings resulting from behavior modification reports with a capacity component.

- Navigant verified randomization across the pilot treatment and control group that were behavior modification report recipients to ensure the experimental design could be leveraged for the evaluation. The results suggested allocation was consistent with random assignment (refer to Appendix A).
- To estimate incremental savings associated with the peak reduction messaging, Navigant compared coincident peak demand and electric energy use for behavior modification report recipients that also received peak reduction messaging to report recipients that did not receive peak reduction messaging (Table 4).

Table 3. Group Used to Estimate Incremental Savings*

2016 Pilot	HER Recipient
Treatment	53,932
Control	63,620

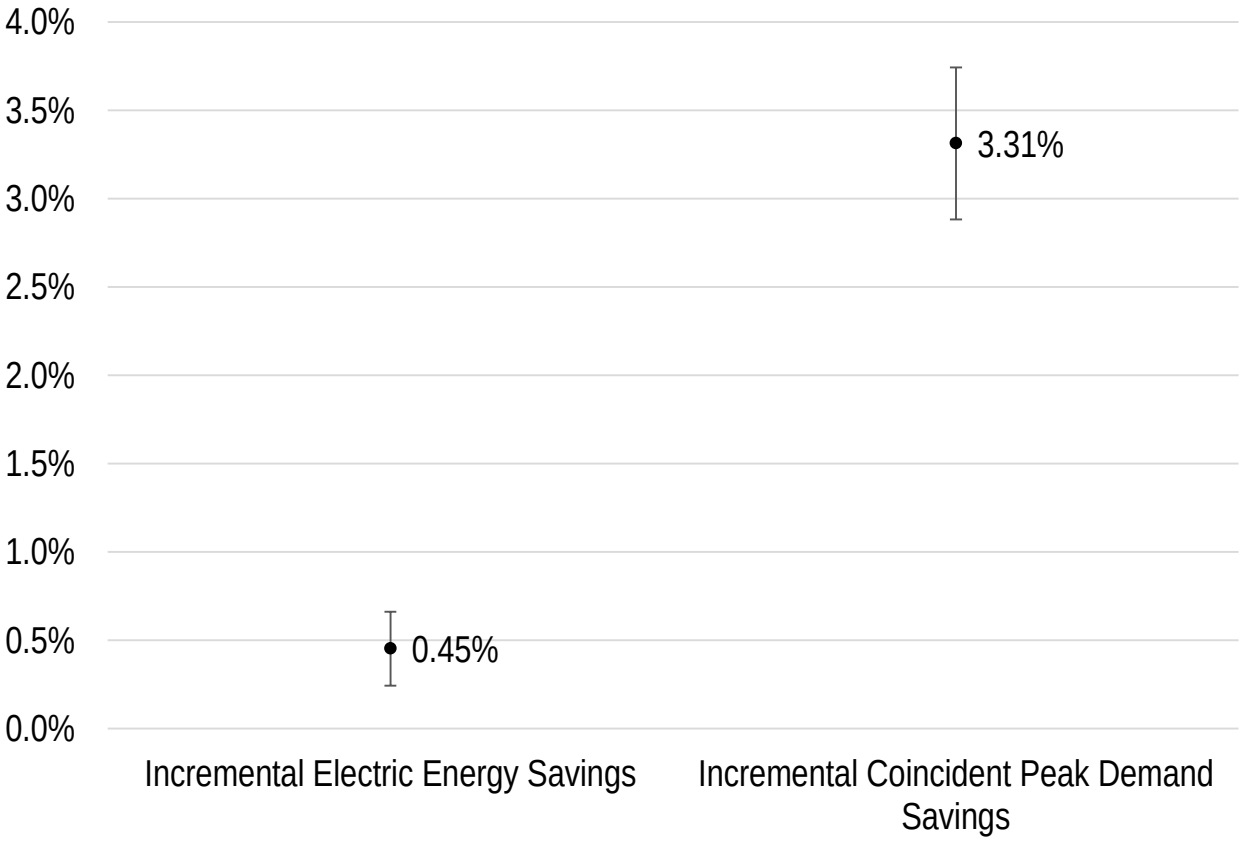
*Number of program participants for which AMI data are available.

- Next, Navigant used regression analysis to estimate incremental savings associated with the capacity-specific messaging.[1]
  - *Coincident Peak Demand:* A lagged dependent variable model was used to estimate demand reduction during 3 PM to 6 PM on two event days that corresponded with DTE Energy's 2016 system peak (August 10 and August 11). Refer to Appendix B for the model specification.
  - *Electric Energy Savings:* A linear fixed effects model was used to estimate 2016 energy savings. This approach is consistent with the approach used to estimate energy savings for the behavior modification report. The time period for the analysis was January 1, 2016 through December 31, 2016 (the pre-program period was 2015). Refer to Appendix C for the model specification.

[1]It is not expected the addition of messaging targeting peak reduction will result in customers signing up for additional energy efficiency programs. As a result, a cross-program participation analysis was not conducted.

The incremental savings associated with the peak reduction component is 0.45% in electric energy savings and 3.31% in coincident peak demand savings.

Figure 1. Savings Estimate for Peak Reduction Component



Note: Error bars reflect 90% confidence interval.

The estimated savings represent incremental savings and should be summed with the deemed savings for the behavior modification report.

Table 4. Savings Summary for the Behavior Modification Report

Energy Savings	Usage Band	Year 1	Year 2	Year 3	Year 4	Year 5
Annual Gas Energy Savings	N/A	0.64%	0.71%	0.72%	0.77%	0.69%
Annual Electric Energy Savings[1]	Average (7 – 9 MWh)	1.05%	1.34%	1.45%	1.55%	1.66%
	High (9 – 11 MWh)	1.20%	1.68%	1.82%	1.95%	2.06%
Coincident Peak Demand Savings	Average (7 – 9 MWh)	2.00%	2.01%	2.18%	2.33%	2.49%
	High (9 – 11 MWh)	2.00%	2.52%	2.73%	2.93%	3.09%

Source: 2017 Michigan Energy Measures Database

The incremental savings associated with the peak reduction component is 0.45% in electric energy savings and 3.31% in coincident peak demand savings.

Table 5. Savings Summary for the Behavior Modification Report with Peak Reduction Component

Energy Savings	Usage Band	Year 1	Year 2	Year 3	Year 4	Year 5
Annual Gas Energy Savings	N/A	0.64%	0.71%	0.72%	0.77%	0.69%
Annual Electric Energy Savings[1]	Average (7 – 9 MWh)	1.50%	1.79%	1.90%	2.00%	2.11%
	High (9 – 11 MWh)	1.65%	2.13%	2.27%	2.40%	2.51%
Coincident Peak Demand Savings	Average (7 – 9 MWh)	5.31%	5.32%	5.49%	5.64%	5.80%
	High (9 – 11 MWh)	5.31%	5.83%	6.04%	6.24%	6.40%

Source: 2017 Michigan Energy Measures Database

[1]At least ten peak demand reduction messages must be delivered to claim the incremental energy savings of 0.45%.

- The savings values represent the sum of the 2017 Michigan Energy Measures Database (MEMD) savings values for the behavior modification report plus the incremental savings estimated (0.45% electric energy and 3.31% coincident peak demand).
- These savings values should be revised with any update to the MEMD savings values for the behavior modification report.

To calculate savings, percent savings is multiplied by average usage or average coincident peak demand of the control group and the number of participating households. See below for an illustrative example.

Table 6. Savings Summary for the Behavior Modification Report with Peak Reduction Component

Energy Savings	Usage Band	Year 1	Year 2	Year 3	Year 4	Year 5
Annual Gas Energy Savings	N/A	0.64%	0.71%	0.72%	0.77%	0.69%
Annual Electric Energy Savings[1]	Average (7 – 9 MWh)	1.50%	1.79%	1.90%	2.00%	2.11%
	High (9 – 11 MWh)	1.65%	2.13%	2.27%	2.40%	2.51%
Coincident Peak Demand Savings	Average (7 – 9 MWh)	5.31%	5.32%	5.49%	5.64%	5.80%
	High (9 – 11 MWh)	5.31%	5.83%	6.04%	6.24%	6.40%

- Gas Savings (Assumptions – Year 2, 10,000 customers, average usage of 1,300 therms)

  $$EnergySavings = THMSavingsRate * CtrlUsage * NumHouseholds$$

  92,300 Therms = 0.71% * 1,300 Therms * 10,000

- Electric Savings (Assumptions – Year 2, 10,000 customers, average usage of 8 MWh)

  $$EnergySavings = kWhSavingsRate * CtrlUsage * NumHouseholds$$

  1,432,000 kWh = 1.79% * 8,000 kWh * 10,000

- Coincident Peak Demand Savings (Assumptions – Year 2, 10,000 customers, average usage of 8 MWh, coincident peak demand of 5 kW)

  $$DmdSavings(kW) = kWSavingsRate * CtrlDmd * NumHouseholds$$

  2,660 kW = 5.32% * 5 kW * 10,000

Navigant's analysis ensures the allocation of customers in the pilot program is consistent with random assignment.

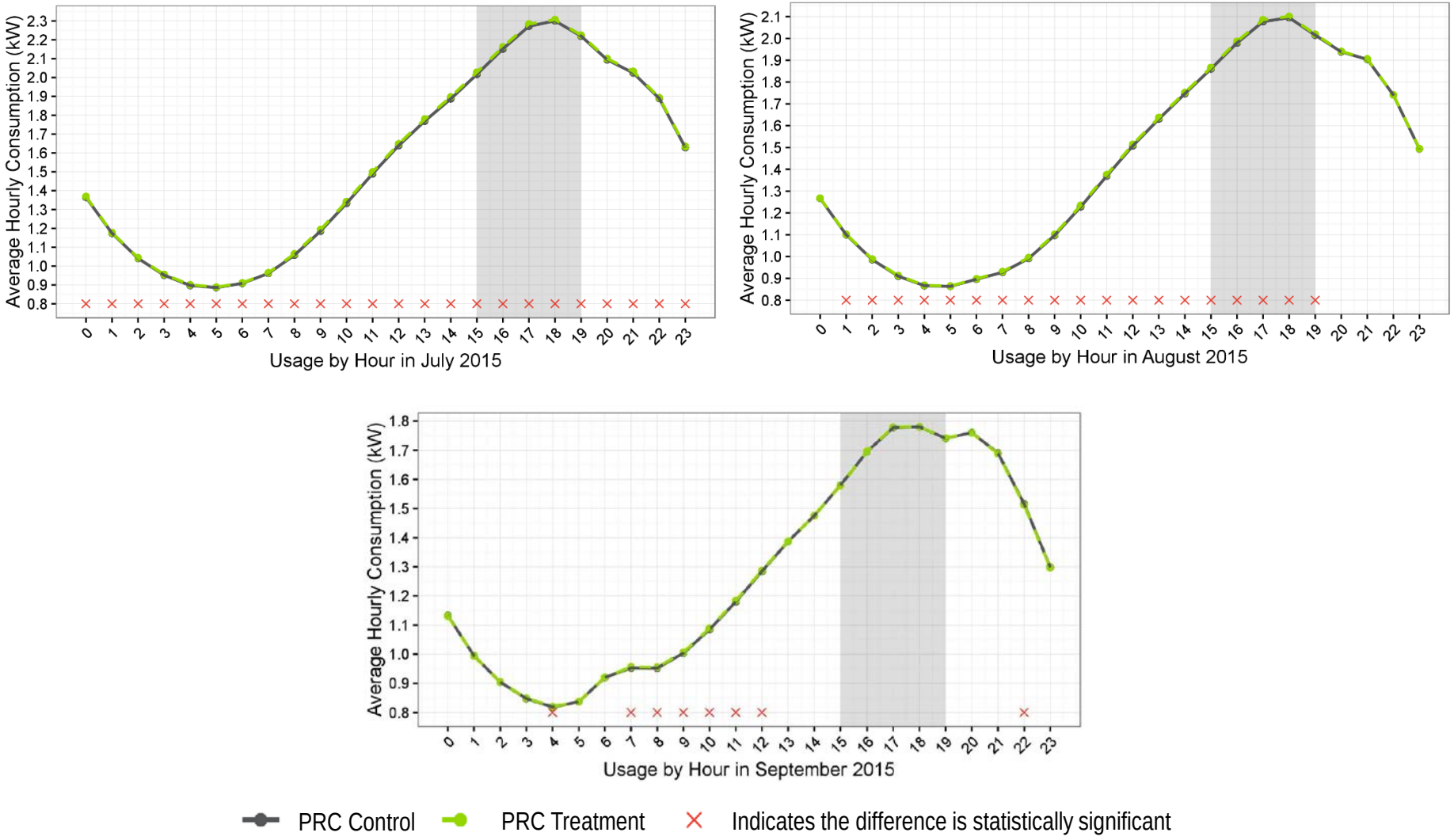
» Navigant conducted the following analysis (referred to as the "RCT Check") to validate randomization:

1. t-tests on the difference in hourly demand by month for the summer season (July, August, September) prior to the start of the program to determine if the mean usage was statistically different between the two groups after accounting for differences in the variance.
2. Plots of average hour demand by month to determine if the mean demand between the two groups was practically or statistically different.
3. A regression analysis on the pre-program summer season data, regressing usage on a binary indicator of treatment and a set of hourly, daily, and monthly fixed effects.

» The implementation contractor, Oracle, conducted randomization using monthly usage. As a result, Navigant also conducted t-tests and made plots of the difference in average monthly usage for the entire year prior to the program to determine if monthly usage was statistically different across the two groups.

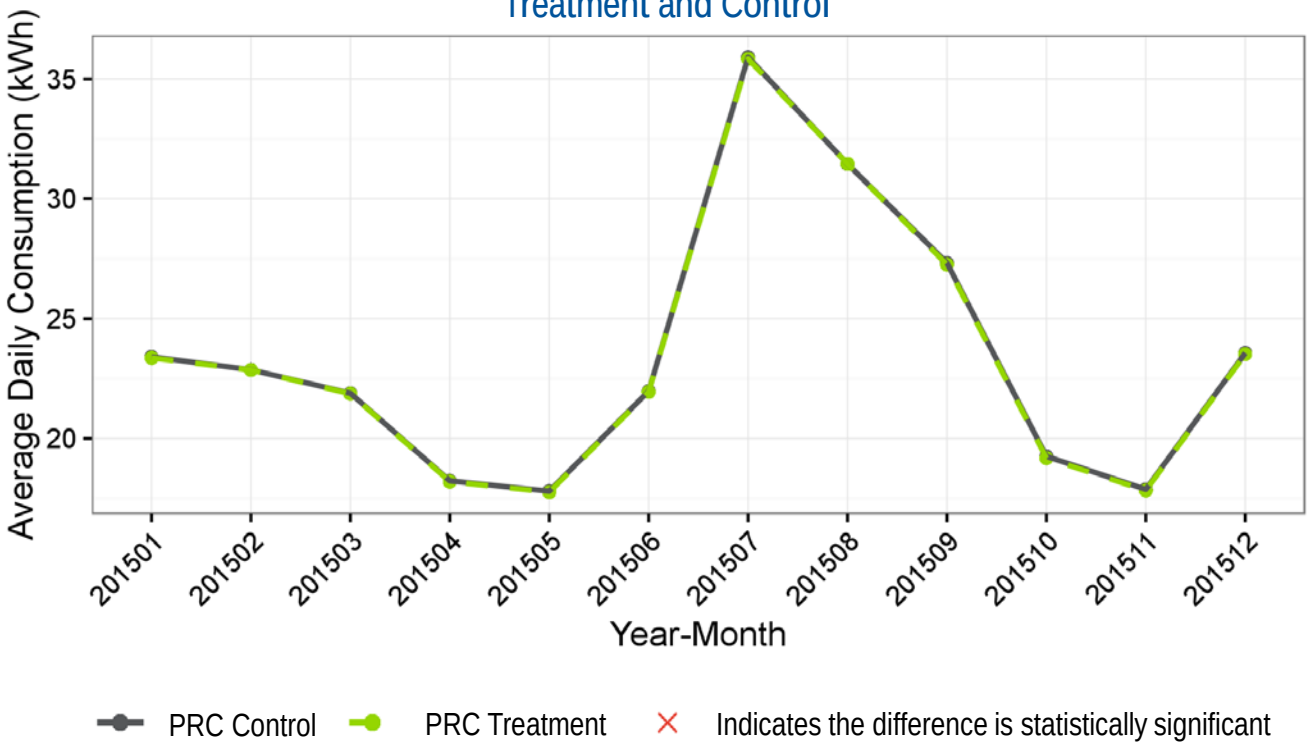
The RCT check revealed there were statistical differences between the two groups. The differences did occur during event hours and some were in the hundredths of a kWh.

Figure C9. RCT Check of 2016 Cohort Using AMI Data, HER Recipient Capacity Component Treatment and Control



To ensure the differences in the hourly t-tests were due to random chance, Navigant also compared average monthly usage of the 2016 behavior modification report recipient with a peak reduction component treatment and control groups for the pre-program year (2015).

Figure C10. RCT Check of 2016 Cohort Using Monthly Data,
Behavior Modification Report Recipient with a Peak Reduction Component
Treatment and Control



Using both sets of results, Navigant concludes the group was consistent with random assignment and can be used to estimate the incremental savings associated with the peak reduction component in 2016.

» The model uses only event-day data with lagged hourly demand for the pre-program period acting as a control for any small systematic differences between treatment and control customers.

» Formally, the model is,

$$kW_{it} = \sum_{t=1}^{24} \beta_{1t} hour_t + \sum_{d=1}^{7} \beta_{2d} day_d + \beta_3 \cdot PreUse_{it} + \beta_4 PreSeason_{it} + \sum_{t=1}^{4} \beta_{5t} Treatment_i \cdot EventHour_t + \sum_{t=1}^{2} \beta_{6t} Treatment_i \cdot Snapback_t + \sum_{t=1}^{2} \beta_{7t} Treatment_i \cdot PreEvent_t + \varepsilon_{it}$$

Where,

kW_{it} is demand for customer *i* during hour *t.*

$hour_t$ is a dummy variable for hour of the day.

day_d is a dummy variable for day of the week.

$PreUse_{it}$ is demand during hour *t* during the same month *m* in the pre-program period. For example, for customer *i* during hour 16:00 on each day in July 2016, $PreUse$ is average demand during hour 16:00 during July 2015 if customer *i* is in the 2016 BDR Cohort and during July 2014 if customer *i* is in the 2015 BDR Cohort.

$PreSeason_{it}$ is demand during hour *t* of the most recent month without any events. For example, for customer *i* during hour 16:00 on each day in July and August 2016, $PreSeason$ is demand during hour 16:00 during June 2016.

$Treatment_i$ is a dummy variable indicating if customer *i* is in the treatment or control group.

$EventHour_t$ is a dummy variable indicating if hour *t* is during a peak event.

$Snapback_t$ is a dummy variable indicating if hour *t* is during the two hours after a peak event

$PreEvent_t$ is a dummy variable indicating if hour *t* is during the two hours before a peak event

» Navigant's linear fixed effects model determines the program's effect by combining cross-sectional and time-series data in a panel format and comparing pre- and post-program billing data for participants and controls. A fixed effect captures customer-specific factors which do not change over time.

» Formally, the model is,

$$kW_{it} = \alpha_{0i} + \beta_1 Post_t + \beta_2 Treatment_i \cdot Post_t + \varepsilon_{it}$$

Where,

kW_{it} is demand for customer *i* during hour *t.*

α_{0i} is a customer-specific fixed effect that captures factors which do not change over time for customer *i*

$Post_t$ is a binary variable taking value of 0 if month *t* is in the pre-period, and 1 if it is in the program period

$Treatment_i$ is a binary variable identifying whether a customer is in the treatment (1) or control (0) group

ε_{it} is the cluster-robust error term for household *i* in time *t*