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ComEd Home Energy Report Program Decay Rate and Persistence Study – Year Five Research Report

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ComEd Home Energy Report Program Decay Rate and Persistence Study – Year Five Research Report

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[1] On October 11, 2019, Guidehouse LLP completed its previously announced acquisition of Navigant Consulting Inc. In the months ahead, we will be working to integrate the Guidehouse and Navigant businesses. In furtherance of that effort, we recently renamed Navigant Consulting Inc. as Guidehouse Inc.

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1. INTRODUCTION

This report presents the results of the fifth year of research on persistence and decay in ComEd's Home Energy Report (HER) Program. The primary objective is to identify the extent to which household energy savings persisted or decayed once customers no longer received HERs. The appendix presents the impact analysis methodology. Navigant's fifth-year assessment evaluates savings between November 1, 2017 and October 31, 2018.

2. RESEARCH DESCRIPTION

This report extends earlier research which evaluated savings rates one, two, three, and four years after HER termination.[2,3,4,5] By continuing this analysis for a fifth year, Navigant can better identify the rate at which savings diminish following report termination, as this decay is not necessarily constant over time. These results can be used as one data point to determine the persistence factors and measure life for HER programs in the Illinois Technical Reference Manual (IL TRM).[6]

The HER Program is designed to generate energy savings by providing residential customers with information about energy use and conservation. Program participants receive this information in the form of regularly-mailed and emailed HERs that give customers insight into their energy use, including:

- An assessment of how the customer's recent energy use compares to past energy use
- Tips on how to reduce energy consumption, some of which are tailored to the customer's unique circumstances
- Information on how their energy use compares to that of neighbors with similar homes

ComEd discontinued the HER Program for three sets of participants in October 2013. Customers in the Wave 1 terminated report (TR) group received reports for just over four years before they were discontinued; Wave 3 TR customers, for two and a half years; and Wave 5 TR customers, for just over one year. This research examines how savings from the reports persist for the TR customers in the fifth year after the last reports were sent (i.e., in period from November 2017 to October 2018).

Results from this analysis are specific to the study population and ComEd's HER treatment of four print reports annually, monthly electronic HERs, and additional web features. Regulators, evaluators, and utilities should be judicious about extrapolating from Navigant's results to other populations and HER treatments.

[2] Navigant. 2016a. *Home Energy Report Opower Program Decay Rate and Persistence Study*. Presented to Commonwealth Edison Company.
[3] Navigant. 2016b. *Home Energy Report Opower Program Decay Rate and Persistence Study – Year Two*. Presented to Commonwealth Edison Company.
[4] Navigant. 2017. *Home Energy Report Opower Program Decay Rate and Persistence Study – Year Three*. Presented to Commonwealth Edison Company.
[5] Navigant. 2018. *ComEd Home Energy Report Program Decay Rate and Persistence Study – Year Five Research Report*. Presented to Commonwealth Edison Company.
[6] The relevant measure is "Adjustments to Behavior Savings to Account for Persistence" which is measure 6.1.1 in Volume 4 of Version 8 of the IL TRM.

3. Research Results

Annual Savings Decay Rate

Table 3-1 and Table 3-2 present annual decay rates and persistence factors[7] for the three TR groups in each of the five years since customers stopped receiving reports.[8] Navigant calculated persistence for each wave by comparing savings rates of the TR group to those of the continued report (CR) group. The first two years after customers stopped receiving reports, decay rates increased for all three waves. In years three, four, and five, decay rates showed mixed results – increasing for some waves and decreasing for others. Many of the values across the years are not statistically different from one another indicating that we cannot be sure of how decay and persistence are changing over time. The average decay rate across waves was 37 percent in the fifth year of the persistence analysis.

Table 3-1. HER Decay Rates

	Wave 1	Wave 3	Wave 5	Average
Year 1 (Nov 2013 - Oct 2014)	4%	2%	22%	10%
Year 2 (Nov 2014 - Oct 2015)	15%	17%	60%	31%
Year 3 (Nov 2015 - Oct 2016)	39%	18%	47%	35%
Year 4 (Nov 2016 - Oct 2017)	28%	24%	38%	30%
Year 4 Standard Error	*17%*	*13%*	*32%*	-
Year 5 (Nov 2017 - Oct 2018)	14%	31%	65%	37%
Year 5 Standard Error	19%	16%	31%	-

Source: Navigant analysis

Table 3-2. HER Persistence Factors

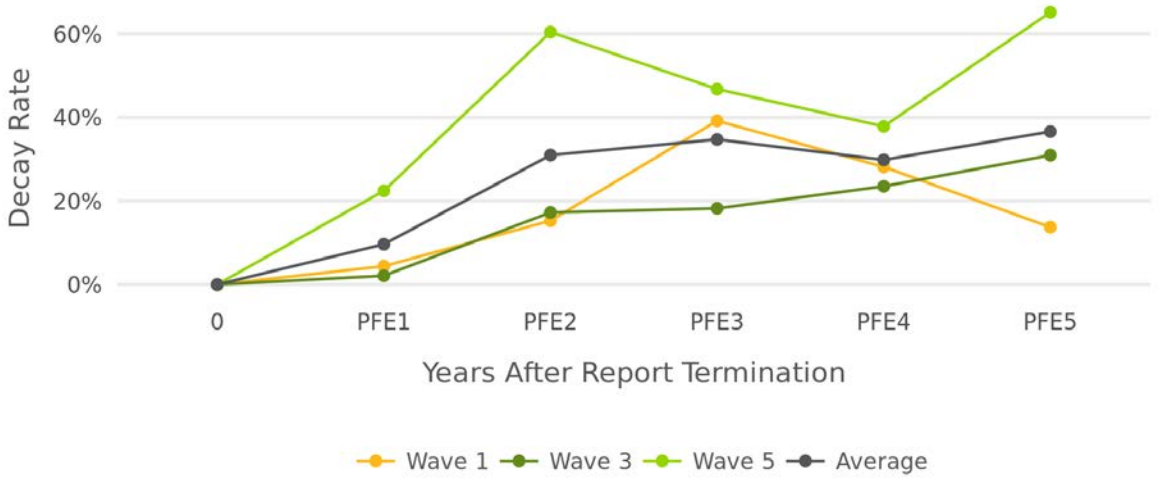
	Wave 1	Wave 3	Wave 5	Average
Year 1 (Nov 2013 - Oct 2014)	96%	98%	78%	90%
Year 2 (Nov 2014 - Oct 2015)	85%	83%	40%	69%
Year 3 (Nov 2015 - Oct 2016)	61%	82%	53%	65%
Year 4 (Nov 2016 - Oct 2017)	72%	76%	62%	70%
Year 5 (Nov 2017 - Oct 2018)	86%	69%	35%	63%

Source: Navigant analysis

The change in the year-over-year decay rate can be more clearly seen in Figure 3-1. The decay rates vary across waves and do not display a clear linear or exponential pattern.

[7] The persistence factor is equal to one minus the decay rate.
[8] These estimates assume a resident move-out-rate of 6 percent for years one through four and 10.1 percent for year five. The year five move out rate was updated to 10.1 percent to match the move-out rate calculated for ComEd's CY2018 HER Program evaluation.

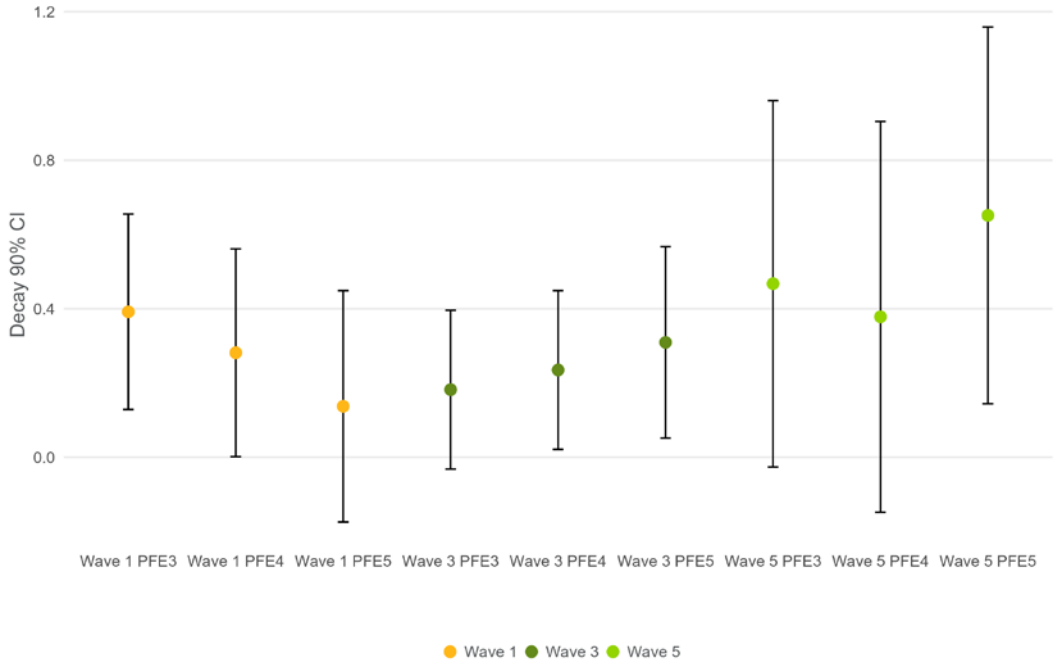
Figure 3-1. Decay Rate



Note: PFE_X = Persistence Factor Electric in Year X.
Source: Navigant analysis

Figure 3-2 shows the 90 percent confidence interval for the decay rates calculated in the third, fourth, and fifth year after reports stopped; a narrower confidence interval indicates more certainty in the results while a wider confidence interval indicates less. When the confidence bound on the decay rate includes zero, it indicates the savings for the TR group are not statistically different from the CR group; when the confidence bound includes one, it means the savings for the TR group are not statistically different from zero. Based on Wald tests, Persistence Factor Electric 5 (PFE_5) decay rates were not statistically different from PFE_4 or PFE_3 estimates for each wave indicating there is little certainty in how decay is changing over time. Even in the absence of statistical significance, the point estimate is still our best estimate of the decay rate, although the results should be considered uncertain. For Wave 1, the point estimate of decay fell from 39% for PFE_3 to 14% for PFE_5, while for Wave 3 the point estimate grew from 18% to 31%. For Wave 5, the point estimate of the decay rate was 47% in PFE_3, fell to 38% in PFE_4, and then grew to 65% in PFE_5. In addition, for Wave 5 the confidence bound on PFE_5 includes one on the high end meaning that that wave did not have any statistically significant savings five years after reports stopped.

Figure 3-2. Decay Rate Comparison for PFE 3, 4, and 5



Note: PFE_X = Persistence Factor Electric in Year X.
Source: Navigant analysis

The IL TRM provides HER energy savings persistence values based on existing research and extrapolation of those findings. Table 3-3 shows those figures relative to Navigant's research using ComEd data. The year column identifies the temporal relationship of the data to report termination. For example, PFE_1 is one year after customers stopped receiving HERs. The persistence factors from Navigant's analysis decreased each year, except for PFE_4 when there was a slight increase. Throughout the years, Navigant's persistence factors are higher than the TRM and may suggest a measure life longer than five years. This is likely driven by the length of treatment prior to report termination which was up to four years for the ComEd waves being studied and could also be affected by differences in program design (for example, if one wave had more email coverage than another wave). A five year measure life is supported by the fact that Wave 5, which had the shortest treatment before report termination, did not have any statistically significant savings in this year's analysis.

Table 3-3. IL TRM and Navigant Estimated Persistence Factors

Year	TRM Persistence Factors	Navigant Analysis Persistence Factors
	100%	100%
PFE_1	80%	90%
PFE_2	54%	69%
PFE_3	31%	65%
PFE_4	15%	70%
PFE_5	0%	63%

Source: Navigant analysis and IL TRM v8.0 Vol 4 Measure 6.1.1

Table 3-4 summarizes wave results for the fifth year after report termination. Results are separated by CR and TR customers to identify the number of participants and savings related to each group. Because the analysis period does not match up with a typical ComEd program year, this study did not estimate legacy uplift savings.[9]

Table 3-4. HER Total Savings from November 2017 - October 2018

Savings Category	Wave 1 CR	Wave 1 TR	Wave 3 CR	Wave 3 TR	Wave 5 CR	Wave 5 TR
Number of Participants	19,304	5,934	130,545	7,092	5,100	5,060
Sample Size - Treatment	18,262	5,625	123,723	6,717	4,633	4,638
Sample Size - Control	27,807		33,959		6,036	
Percentage Savings	2.55%	2.20%	2.40%	1.65%	1.95%	0.68%
Standard Error	*0.31%*	*0.49%*	*0.19%*	*0.41%*	*0.68%*	*0.67%*
Verified Net Savings, Prior to Uplift Adjustment, MWh*	6,448	1,708	51,770	1,933	1,926	676
Standard Error	*776*	*381*	*4,057*	*478*	*673*	*667*
Savings Uplift in Other EE Programs in Analysis Period, MWh	53	14	471	24	4	21
Verified Net Savings, MWh†	6,395	1,694	51,300	1,909	1,923	654

*Total savings are pro-rated for participants that closed their accounts during the analysis period.
†Gross savings adjusted for savings uplift are equal to gross savings less the uplift of savings in other EE programs.
Source: Navigant analysis.

4. Findings and Recommendations

Finding 1. Relative to the year four persistence study, decay rates decreased for Wave 1 but increased for Waves 3 and 5, although the differences were not statistically significant. These decay rates are lower than the values found in IL TRM Version 8.0 (note lower decay means higher persistence),[10] and average 37 percent across all waves. However, year five wave decay rates continue to show high levels of uncertainty based on large confidence bounds. The uncertainty of the results cautions against using this study in isolation to inform the IL TRM.

Recommendation 1. The results from this analysis are specific to the study population (of ComEd Waves 1, 3, and 5) and as such do not capture the full spectrum of waves and program design in Illinois' electric HER programs across utilities. Additionally, the results have a high level of uncertainty and there is no clear linear or exponential pattern to the decay. Therefore, to capture a broader spectrum of possible persistence, Navigant recommends that the IL TRM combine this analysis with other relevant studies[11] to review the persistence factors for Version 9 for the Illinois utilities to use for their next planning cycle.

[9] When legacy uplift was included in Navigant's first-year persistence study, the difference in total savings made a negligible impact on the decay rate, so the legacy adjustment was not included in this analysis.
[10] See Measure 6.1.1, Volume 4.
[11] For example, DNV-GL 2014, Home Energy Report Program 2013 Impact Evaluation. Presented to Puget Sound Energy.

5. Appendix 1. Impact Analysis Methodology

5.1 Statistical Models Used in the Impact Evaluation

Navigant used statistical analysis appropriate for an RCT to calculate HER Program persistence savings, which is consistent with annual program year evaluations.[12] This approach estimated program impacts using two methods: a lagged dependent variable (LDV)[13] regression and a linear fixed-effects regression (LFER) applied to monthly billing data. Navigant calculated persistence and decay by comparing the TR group to the CR group for each wave.

5.1.1 Lagged Dependent Variable Model

The LDV model controls for non-treatment differences in energy use between treatment and control customers using lagged energy use as an explanatory variable. The model frames energy use in calendar month *t* of the post-program period as a function of both the treatment variable and energy use in the same calendar month of the pre-program period. The underlying logic is that systematic differences between control and treatment customers will be reflected in differences in their past energy use, which is highly correlated with their current energy use. Formally, the model is shown in Equation 5-1.

Equation 5-1. Lagged Dependent Variable Model

$$ADU_{kt} = \beta_1 Treatment_k \cdot TR_k + \beta_2 Treatment_k \cdot CR_k + \sum_J \beta_{3j} Month_{jt} + \sum_J \beta_{4j} Month_{jt} \cdot ADUlag_{kt} + \varepsilon_{kt}$$

Where,

ADU_{kt}	is average daily consumption of kWh by household *k* in bill period *t*
$Treatment_k$	is a binary variable taking a value of 0 if household *k* is assigned to the control group, and 1 if assigned to the treatment group
TR_k	is a binary variable taking a value of 1 if household *k* is assigned to the terminated report group
CR_k	is a binary variable taking a value of 1 if household *k* is assigned to the continued report group
$ADUlag_{kt}$	is household *k*'s energy use in the same calendar month of the pre-program year as the calendar month of month *t*
$Month_{jt}$	is a binary variable taking a value of 1 when *j* = *t* and 0 otherwise[14]

[12] See for example: Navigant Consulting Inc. 2016. "Home Energy Report Opower Program PY8 Evaluation Report." Presented to Commonwealth Edison Company.
[13] The model is identical to the post-program regression (PPR) model used in previous evaluations. We have changed the nomenclature to better align with academic research and because LDV is more descriptive of the model structure than PPR.
[14] In other words, if there are *T* post-program months, there are *T* monthly dummy variables in the model, with the dummy variable $Month_t$ to take a value of 1 at time t. These are, in other words, monthly fixed effects.

e_{kt} is the cluster-robust error term for household *k* during billing cycle *t;* cluster-robust errors account for heteroskedasticity and autocorrelation at the household level.[15]

The coefficients β_1 and β_2 are the estimates of average daily kWh energy savings due to the program in the fourth year after reports were terminated for the TR and CR groups, respectively.

5.1.2 Linear Fixed Effects Regression Model

The version of the LFER model used by Navigant is one in which average daily consumption of kWh by household *k* in bill period *t*, denoted by ADU_{kt}, is a function of the following five terms:

1. The binary variable $Treatment_k$
2. The binary variable $Post_t$, taking a value of 0 if month *t* is in the pre-treatment period, and 1 if in the post-treatment period
3. The interaction between these variables, $Treatment_k \cdot Post_t$, taking the value of 1 at time t for household k if a treatment household is operating in the post-treatment period
4. The binary variable TR_k taking a value of 1 if the customer was in the TR group and 0 otherwise
5. The binary variable CR_k taking a value of 1 if the customer was in the CR group and 0 otherwise

Formally, the LFER model is shown in Equation 5-2.

Equation 5-2. Linear Fixed Effects Regression Model

$$ADU_{kt} = \alpha_{0k} + \alpha_1 Post_t + \alpha_2 Treatment_k \cdot TR_k \cdot Post_t + \alpha_3 Treatment_k \cdot CR_k \cdot Post_t + \varepsilon_{kt}$$

Three observations about this specification deserve comment. First, the coefficient α_{0k} captures all household-specific effects on energy use that do not change over time, including those that are unobservable to the researcher. Second, α_1 captures the average effect across all households of being in the post-treatment period. Third, the effect of being both in the treatment group and in the post period – the effect directly attributable to the program – is captured by the coefficient α_2 for the TR group and α_3 for the CR group. In other words, whereas the coefficient α_1 captures the change in average daily kWh use between the pre- and post-treatment time periods for both the treatment and the control group, the sums $\alpha_1 + \alpha_2$ and $\alpha_1 + \alpha_3$ capture this change exclusively for the TR treatment group and CR treatment group, and so α_2 and α_3 are the estimates of average daily kWh energy savings due to the program in the fourth year after reports were terminated for the TR and CR groups, respectively.

5.2 Estimating Decay of Savings

The decay rate for any year *t* is equal to one minus the ratio of the percentage savings for the TR group in the t^{th} year after the reports were discontinued to percentage savings for the CR group in that same year. Equation 5-3 shows this calculation, where δ_t is the decay rate to the t^{th} year after reports were discontinued.

[15] Ordinary Least Squares (OLS) regression models assume that the data are homoscedastic and not autocorrelated. If either of these assumptions are violated, the resulting standard errors of the parameter estimates are incorrect (usually downward biased). A random variable is heteroscedastic when its variance is not constant over the variable's entire distribution. A random variable exhibits autocorrelation when its error term in one period is correlated with the error terms in at least some of the previous periods.

Equation 5-3. Decay Rate to Year *t*

$$\delta_t = 1 - \frac{\%\ Savings\ for\ TR\ in\ t^{th}\ year\ after\ reports\ stop}{\%\ Savings\ for\ CR\ in\ t^{th}\ year\ after\ reports\ stop\ for\ TR}$$

Equation 5-4 identifies the formula to calculate annual decay, where Δ is the decay rate, and *t* is the number of years since customers stopped receiving reports.

Equation 5-4. Average Annual Decay Rate

$$\Delta = -\frac{\ln(1-\delta_t)}{t}$$

5.3 Accounting for Uplift in Other Energy Efficiency Programs

5.3.1 Accounting for Uplift in the Analysis Period

The reports sent to participating households included energy-saving tips, some of which encouraged participants to enroll in other ComEd energy efficiency (EE) programs. If participation rates in other EE programs are the same for the HER participant and control groups, the savings estimates from the regression analyses are already "net" of savings from the other programs, as this indicates the HER Program did not increase or decrease participation in the other EE programs. However, if the HER Program affects participation rates in other EE programs, then savings across all programs are lower than indicated by the simple summation of savings in the HER and EE programs. For instance, if the HER Program increases participation in other EE programs, the increase in savings may be allocated to either the HER Program or the EE program, but cannot be allocated to both programs simultaneously.[16]

Navigant used a difference-in-difference (DID) statistic to estimate uplift in other EE programs between November 2017 and October 2018. To calculate the DID statistic, Navigant subtracted the change in the participation rate in another EE program between the analysis period and the pre-program year for the control group from the same change for the treatment group. For instance, if the rate of participation in an EE program during the analysis period is five percent for the treatment group and three percent for the control group, and the rate of participation during the year before the start of the HER Program is two percent for the treatment group and one percent for the control group, then the rate of uplift due to the HER Program is one percent, as reflected in Equation 5-5.

Equation 5-5. DID Statistic Calculation

$$(analysis\ period\ treatment\ group\ participation - prePY\ treatment\ group\ participation)$$
$$- (analysis\ period\ control\ group\ participation - prePY\ control\ group\ participation)$$
$$= DID\ statistic$$
$$(5\% - 2\%) - (3\% - 1\%) = 1\%$$

The DID statistic generates an unbiased estimate of uplift when the baseline average rate of participation is the same for the treatment and control groups, or when they are different due only to differences between the two groups in time-invariant factors, such as residency square footage.

A simple difference in participation rates during the analysis period provides an alternative unbiased estimate of uplift when the baseline average rate of participation in the EE program is the same for the

[16] It is not possible to avoid double counting of savings generated by programs for which tracking data are not available, such as upstream compact fluorescent lamp (CFL) programs.

treatment and control groups. Navigant used this alternative statistic –the "post-only difference" (POD) statistic –in cases where the EE program did not exist for the entire pre-program year.

Navigant examined uplift associated with the following EE programs: Fridge Freezer Recycling (FFR), Home Energy Assessments (HEA), Single Family Retrofits, Multi-family Retrofits, Weatherization (Wx) Rebates, and Heating and Cooling (HVAC) Rebates.[17,18]

5.3.2 Accounting for Legacy Uplift

The uplift adjustment methodology described only accounts for uplift which occurs in the current year because EE program tracking files in any given program year only capture new measures installed in that year, regardless of expected measure lives. However, for other EE programs with multi-year measure lives, HER Program savings capture the portion of their savings due to uplift in each year of that program's measure life. For instance, a measure with a ten-year measure life that was installed in PY2 would generate savings captured in the HER Program savings not just in PY2, but in PY3 through PY11 as well.

Since the analysis period for this study is off from a regular program year Navigant was unable to accurately estimate legacy uplift for this analysis period.

6. Appendix 2. Impact Analysis Detail

Wave LDV and LFER model results are available upon request. Across the two models, the parameter estimates are not statistically different; that is, the estimates for each model are within the 90 percent confidence bounds for the other model. Furthermore, the pattern across the different program waves between the two models is very similar.

7. Appendix 3. Detailed Data Cleaning

Table 7-1 through Table 7-3 give counts and percentages of customers and observations removed during the data cleaning process. The tables also provide the percentage of customers or observations removed. It is evident from the tables that the percentage of customers or observations removed was very similar across the treatment and control groups for each wave. This suggests that non-random biases were not introduced into the data by our cleaning.

[17] These are the names used for these programs in CY2018.
[18] ComEd has other residential programs that were not included in the analysis. The Appliance Rebate, Elementary Education, Lighting Discounts, Middle School Take-Home Kits, Food Bank LED Distribution, and Low Income Kits programs do not track participation at the customer level, and so do not have the data necessary for the uplift analysis. Double counting between the Residential New Construction and Affordable Housing New Construction Programs and HER is not possible due to the requirement that HER participants have sufficient historical usage data.

Table 7-1. Customers and Observations Removed by Data Cleaning Step (Wave 1)

Data Cleaning Step Wave 1	Customers		Observations		Customer % Change		Observation % Change	
	Treatment	Control	Treatment	Control	Treatment	Control	Treatment	Control
Raw Data	46,503	43,861	4,805,838	4,523,152	-	-	-	-
Subset to pre/post periods and desired customers	23,902	27,824	565,042	657,799	49%	37%	88%	85%
Remove exact duplicate observations	23,902	27,824	565,042	657,799	0%	0%	0%	0%
Bill Flattening	23,902	27,824	551,873	642,223	0%	0%	2%	2%
Exclude outliers	23,901	27,820	551,568	641,902	0%	0%	0%	0%
Remove pre-period data (for LDV analysis)	23,896	27,817	274,696	319,762	0%	0%	50%	50%
Remove observations without a monthly pre-use value (for LDV analysis)	23,887	27,807	265,700	309,145	0%	0%	3%	3%

Source: Navigant analysis

Table 7-2. Customers and Observations Removed by Data Cleaning Step (Wave 3)

Data Cleaning Step Wave 3	Customers		Observations		Customer % Change		Observation % Change	
	Treatment	Control	Treatment	Control	Treatment	Control	Treatment	Control
Raw Data	198,689	49,061	17,588,910	4,350,816	-	-	-	-
Subset to pre/post periods and desired customers	130,481	33,973	3,083,782	802,918	34%	31%	82%	82%
Remove exact duplicate observations	130,481	33,973	3,083,782	802,918	0%	0%	0%	0%
Bill Flattening	130,481	33,973	3,007,488	782,777	0%	0%	2%	3%
Exclude outliers	130,481	33,973	3,007,146	782,680	0%	0%	0%	0%
Remove pre-period data (for LDV analysis)	130,458	33,964	1,489,447	387,761	0%	0%	50%	50%
Remove observations without a monthly pre-use value (for LDV analysis)	130,440	33,959	1,443,413	375,565	0%	0%	3%	3%

Source: Navigant analysis

Table 7-3. Customers and Observations Removed by Data Cleaning Step (Wave 5)

Data Cleaning Step Wave 5	Customers		Observations		Customer % Change		Observation % Change	
	Treatment	Control	Treatment	Control	Treatment	Control	Treatment	Control
Raw Data	19,886	12,756	1,183,630	758,298	-	-	-	-
Subset to pre/post periods and desired customers	9,290	6,045	213,797	139,091	53%	53%	82%	82%
Remove exact duplicate observations	9,290	6,045	213,797	139,091	0%	0%	0%	0%
Bill Flattening	9,290	6,045	208,468	135,626	0%	0%	2%	2%
Exclude outliers	9,290	6,045	208,418	135,577	0%	0%	0%	0%
Remove pre-period data (for LDV analysis)	9,283	6,041	104,681	68,263	0%	0%	50%	50%
Remove observations without a monthly pre-use value (for LDV analysis)	9,271	6,036	97,655	63,491	0%	0%	7%	7%

Source: Navigant analysis