Getting the Bead of Hardship

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ABSTRACT

This paper discusses findings from the survey research conducted with over 44,000 customers of three investor owned utilities (IOUs) in a randomized control trial (RCT) pilot experiment to test whether and to what extent Time Of Use (TOU) rates impact customers' economic and health outcomes. Using a mixed mode approach (electronic, paper, and phone), the authors attempted a census of pilot participants. Questions on response to the assigned rate, economic and health effects, self-reported behaviors, and household characteristics formed the focus of the survey. Due to the RCT design of the pilot, rate and climate effects can be examined directly through comparison of treatment and control groups.

The first survey was structured specifically to provide insight on any negative economic or health effects on customers on the TOU rates to inform the mandatory TOU rollout scheduled for 2019. The robust nature of the pilot design and this survey provide the first ever RCT assessment of customer response to TOU rates in North America.

Results indicate that the mixed-mode survey approach was very effective for collecting data from pilot customers, achieving an 82% response rate. The economic index created to measure customers' economic difficulty also performed well. In addition, a large majority of customers on TOU rates did not experience significantly more economic or health difficulty compared to customers on the control rate. However, customers in one of 42 groups across the IOUs reported higher average economic difficulty compared to Control groups, and significantly more customers in two of the groups reported medical events due to excessive heat in their home during the first summer of the pilot.

Introduction and Background

Time of Use (TOU) rates are a way to manage and control peak and send an easy signal to customers about the price differential of energy at various times of day. With the increased use of behind the meter distributed energy resources (solar, storage, and electric vehicles), being able to send an easy price signal to customers is potentially very important so customers can make better choices of when to use electricity and thus improve grid operations. In preparation for mandatory TOU rates, the public utility commission in California required the investor owned utilities (IOUs) to implement a pilot. The main questions the Opt-in Pilot sought to address were: (i) Would customers be able to respond to TOU price signals, and (ii) Would any households experience substantial financial or health effects as a result of the rates?

The IOUs recruited over 55,000 people into the pilot with substantial incentive offers. Recruited customers were then randomly assigned to one of three TOU rates or a standard rate. Low-income were over-recruited in the extreme climate zones to ensure sufficient sample for study even if there were substantial attrition. This approach, while for an opt-in pilot, resulted in a randomized control trial (RCT) on response to the TOU rates.

The pilot is operating in 2016 and 2017 with two surveys: Fall 2016 and Summer 2017. This paper reports results from analyses of the survey implemented in Fall 2016 to determine whether TOU rates caused treatment group customers to experience unreasonable economic and/or health hardship,

particularly low-income customers, compared to corresponding control group customers not on TOU rates. On the Fall 2016 survey, the TOU treatment group participants experienced the Opt-in Rates between the months of July 2016- November 2016.

Methods & Data

The research team conducted a survey of IOU customers in a randomized control trail (RCT) to test the impacts TOU rates have on IOU customers' economic and health well-being during the summer months. The team used customers' survey responses to create economic and health well-being metrics and compared results between Control and Rate groups to determine if the TOU rates increased economic and/or health hardship, particularly for low-income customer segments.

Experimental Design

IOU customers were recruited into the RCT using a pay-to-play strategy, in which they were offered a $100 bill credit and first year bill protection to participate in a two-year program. This strategy was used to replicate as best as possible the types of customers who would likely be on TOU rates if a default enrollment approach was implemented compared to an opt-in enrollment approach. Far fewer customers, particularly low-income customers, would likely opt-out of a default approach than would likely opt-in to an opt-in approach.

Customers were randomly assigned to a Control group, who remained on their electricity rate that varied by how much they use, and to two (SDG&E) or three (PG&E, SCE) TOU Rate groups (Rate 1, Rate 2, or Rate 3) as shown in Table 1. Electricity prices for the Rate groups varied by on-peak and off-peak hours, and each Rate group had different on-peak and off-peak hours and rates. The least complex rates include Rate 1 for PG&E and SDG&E, and Rate 2 for SCE; the most complex rates include Rate 2 for SDG&E and Rate 3 for PG&E and SCE.

In addition, legislation requires that the CPUC ensure that any default TOU rate schedule does not cause unreasonable economic or health hardship, especially for low-income customers in hot climate regions. To test for this, customers were divided into two or three climate regions, based on average temperatures of where they reside: hot region (PG&E and SCE), moderate region (all IOUs), and cool region (all IOUs) (Table 1). Customers were also divided into two segments based on whether they are enrolled in the California Alternate Rates for Energy (CARE) program and Federal Electric Rates Assistance (FERA) program (Table 1): CARE/FERA customers and non-CARE/FERA customers.[1,2]

Table 1. Experimental Design: Segments and TOU Rate Groups by IOU

Climate Region	Segment	Control vs. Rate 1	Control vs. Rate 2	Control vs. Rate 3
Hot	Non-CARE/FERA	PG&E, SCE	PG&E, SCE	PG&E, SCE
	CARE/FERA			
Moderate	Non-CARE/FERA	All IOUs	All IOUs	PG&E, SCE
	CARE/FERA			

[1] Eligibility for CARE and FERA is based on annual household income and household size.
[2] PG&E Rate 1 and SCE Rate 2 included four additional groups, not reported here: Customers eligible for CARE/FERA, seniors, customers below 100% of Federal Poverty Guidelines (FPG), and customers 100% to 200% of FPG.

Climate Region	Segment	Control vs. Rate 1	Control vs. Rate 2	Control vs. Rate 3
Cool	Non-CARE/FERA	All IOUs	All IOUs	PG&E, SCE
	CARE/FERA			

Survey Methods and Data

The IOUs provided the contact data from their customer databases for an attempted census survey of all recruited customers. IOU databases included identifiers for CARE/FERA enrollment and customer segments, estimated annual household income, language preference, and presence of a senior(s) in the household.[3] The survey itself collected data on annual household income, household size, age of household members, and economic and health metrics, among other topics.

The team used an email, mail, and phone mixed-mode survey method to attempt to reach all customers and achieve high response rates.[4] For the web survey mode, customers with email addresses were mailed an invitation letter with a web link, and then two reminder emails, and those without email addresses were mailed an invitation letter with web link, followed by a mailed reminder letter. Non-respondents to the web mode received a mailed paper questionnaire, followed by a mailed postcard reminder; non-respondents to the mail mode received from one to five phone calls. The survey included 53 questions and took about 20 minutes to complete. All respondents received either a $50 (99.4%), $75 (0.2%), or $100 (0.4%) credit on their electricity bill.

The survey was fielded between October and December 2016, and obtained an 82% response rate (Table 2). Response rates varied across the IOUs from 81% to 87%, and across the IOUs' customer segments and experimental groups from a low of 67% to a high of 96%. Sample sizes across the IOUs' customer segments and experimental groups ranged from 271 to 1,616. Analyses comparing respondents to nonrespondents on key demographic characteristics indicate that the response rates were sufficiently high to minimize non-response bias.

Table 2. Survey Completes and Response Rates, by IOU[1]

	PG&E	SCE	SDG&E	Total
Total Sample	20,429	20,108	14,732	55,269
Completes	16,187	15,887	12,484	44,558
Response Rate	81%	80%	87%	82%

[1] Calculated using the Response Rate 1 formula by the American Association for Public Opinion Research (AAPOR). *http://www.aapor.org/AAPOR_Main/media/publications/Standard-Definitions20169theditionfinal.pdf*

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[3] Estimated annual household income data were purchased by the IOUs from a third-party provider.
[4] Survey implementation was based on Dillman's Tailored Design Method. Dillman, Don A., Smyth, Jolene D., Christian, Leah Melani. 2014. *Internet, Phone, Mail and Mixed-Mode Surveys: The Tailored Design Method, 4th edition*. John Wiley: Hoboken, NJ

The survey specifically assessed differences in responses between those customers in the Control groups and those on the TOU rates during the summer months. Differences in response rates between the Control groups and Rate groups were small, ranging from 0% to 6%.

Analytical Methods

To measure whether TOU rates caused customers "economic difficulty" or "health difficulty", the team used survey data to create an economic index and health metric, and compared these between the treatment and control groups. Since economic and health outcomes are complex and multifaceted, merging multiple questions into an index or using them to create a metric makes assessing differences between Control and Rate groups simpler and more valid. The alternative, evaluating a series of individual questions about household's economic and health situations, can provide misleading and/or contradictory outcomes.

Economic Index Development

The economic index was formed using Exploratory Factor Analyses (EFA) testing the underlying connections between survey questions targeted at economic and financial issues -- including an index created by the Consumer Financial Protection Bureau (CFPB) -- and survey questions obtained from other research conducted in California. The EFA identified questions from the customer survey that correlated with one another, and demonstrated coverage of several underlying aspects of the "economic difficulties" concept. These aspects and the survey questions used to measure them are listed below. All the questions were answered by 84% of respondents across the IOUs and customer segments.

- *Consumer Financial Protection Bureau's (CFPB) Financial Well-Being Index*: The abbreviated CFPB index question used in the customer survey is comprised of five Likert scale items.[5] For the first three items, respondents were asked how each describes their situation using a scale including "not at all," "very little," "somewhat," "very well," and "completely." For the last two items, respondents were asked how often each applies to them using a scale including "never," "rarely," "sometimes," "often," and "always." The CFPB items are listed below. Scores derived from the results ranged from 19 to 90, with a score of 90 corresponding to a very financially secure respondent.
  - Because of my money situation, I feel like I will never have the things I want in life.
  - I am just getting by financially.
  - I am concerned that the money I have won't last.
  - I have money left over at the end of the month.
  - My finances control my life.
- *Problems Paying Bills:* Respondents were asked how many times during the study period they had difficulty paying their a) electricity bills and b) bills for other basic needs such as food, housing medicine, and other important bills. Customers could choose none, one time, two times, or three or more times. The response values for the number of times respondents had trouble paying both their electricity bill and other important household bills were summed.[6] Scores range from 0 to 6, with a score of 6 corresponding to six or more times the respondent had trouble paying their important household bills.
- *Concern for Bill Payment:* Respondents were asked the extent to which they agreed with the following statement, using a 0 to 10 scale where 0 means do not at all agree and 10 means

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5 The Consumer Financial Protection Bureau's methods for the abbreviated version of their "Financial Well-Being Scale" were followed. See the following documentation for full methodological details: http://files.consumerfinance.gov/f/201512_cfpb_financial-well-being-user-guide-scale.pdf

6 Cronbach's alpha = .84.

completely agree. The statement is "I often worry whether there is enough money to pay my electricity bill."

- *Number of Alternative Ways Used to Pay Bills:* Respondents were asked how they afforded to pay their electricity bills and/or other basic needs during the study period, and could choose any one of the means listed were included. The number of different methods a respondent used to pay their household bills other than using their current monthly income were summed. Scores range from 0 to 10, with a score of 10 interpreted as the respondent using ten alternative methods to pay their bills.
    o Use current monthly income
    o Use household's savings and other investments
    o Cut back on non-essential spending for things the household wants
    o Reduce household energy usage
    o Borrow money from family, friends, or peers
    o Borrow money using a short-term loan
    o Use credit card that can't be paid off right away
    o Leave rent or mortgage unpaid
    o Leave some household bills unpaid past due dates
    o Received emergency assistance from [IOU]
    o Received emergency assistance from other city or regional programs

Because the range of possible values on the items used in the EFAs varied considerably, respondent values for these variables were standardized into z-scores, in which a score of zero reflects the sample mean and a score of one is one standard deviation away from the mean. By standardizing responses, it is possible to compare responses across items and understand that a z-score response of 3.2 is much more extreme than a response of 0.74.

Throughout this process, statistical models were estimated using 30% and 50% of the full dataset of respondents. This was done for two reasons: 1) to ensure that the same factors loaded on random subsamples of the data of different size (vs. the full dataset) for reliability, and 2) to reduce the excessive statistical power stemming from the very large sample sizes obtained through the survey. The final model explained 67% of the variance in answer choices.[7]

Table 3. EFA Results[1]

Item	Factor Loading	KMO Stat	% Variance Explained	Goodness of Fit
Concern for bill payment	0.869			
Problems paying bills	0.847			
CFPB Financial Well Being	-0.669	0.8	67%	χ^2=50.8, df=2, p<0.001
# of Alternative Ways Used to Pay Bills	0.569			

[1] A Maximum Likelihood extraction method was used.

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[7] 67% of the variance explained means that these four items explain 67% of the variability in answer choices used in the model. Typically, the variance explained from models using survey results range from 20% to 40%. A model that explains 67% of the variability in answer choices suggests a very good fitting model.

Confirmatory factor analysis (CFA) was used to confirm and validate the EFA results. Figure 1 shows the path diagram the correlation between the four items, or inputs, and the latent "Economic Index" variable. The statistics confirm that the model fits the data well.[8]
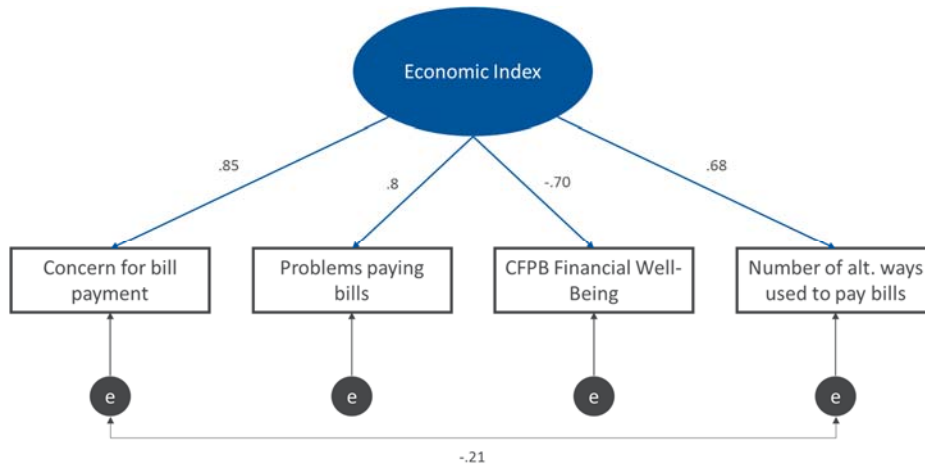

Figure 1. Confirmatory Factor Analysis Results

To assess convergent validity, the Average Variance Extracted (AVE) was calculated, by averaging the squared factor loadings. The above model results in an AVE score of 0.58. A value above .5 is acceptable. To assess reliability of the items in the model, Cronbach's alpha and Composite Reliability (CR) scores were calculated. The resulting Cronbach's alpha of .84 and CR of .84 indicate a good measure of internal consistency between the four items the EFA identified as potential inputs to the economic index metric.

To calculate the final economic index scores, the four items were combined into one metric. For this multi-step process, the z-scored values from the financial well-being index were inverted to match the direction of the other three variables to be included in the index (where higher scores mean higher economic difficulty). Values from these four items were then added into an initial score. To make the metric more transparent, the metric was normalized such that a score of zero means the absence of economic difficulty and 10 means complete economic difficulty as measured by the survey. The following formula was used for normalizing the economic index metric:

$$Economic\ Harship\ Score = \frac{(Initial\ Index\ Score + Min\ Observed\ Index\ Score)}{(Max\ Observed\ Index\ Score + Min\ Observed\ Index\ Score)} * 10$$

Health Metric Development

The health metric is based on a single survey question about health effects from excessive heat, and responses to household characteristics questions. Customers were asked to report the number of times a someone in their household needed medical attention because it was too hot in their home during the summer ("medical event"), using an 11-point scale where 0 means never and 11 means more than ten times. Of the 98% of respondents (43,846) who answered the question, 92.7% (40,663) reported 'never,' 2.4% (1,065) reported one time, 1.4% (599) reported two times, and between 0.8% (345) and 0.2% (69) reported three times to more than ten times. Overall, an average of 7% of customers (3,183) reported a medical event due to excessive heat in their home.

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[8] X^2=1.29, df=1, p=0.165 (a non-significant chi-square indicates a good model fit), RMSEA=0.007 (an RMSEA of less than 0.01 also indicates a good fit), CFI = almost 1 (a CFI over .95 indicates good fit).

To maximize the ability to observe potential health effects caused by TOU rates, household characteristics questions were used to identify the sub-sample for whom the question is most relevant. The primary predictor of a reported medical event is whether the respondent and/or another household member has a disability that requires their home to be cool in the summer. In addition, to link the medical event to energy usage in households with a disabled resident(s), only those respondents who reported having air (AC) conditioning in the home (central AC, room/portable AC, or heat pump) were included in analyses. These respondents potentially could have experienced health difficulties by reducing their use of AC and increasing the temperature in their home to decrease electricity bills or usage.

To statistically investigate whether TOU rates caused health difficulty due to reduced air conditioning use, two-proportion z-tests were used to determine if the Control and Rate groups differed significantly in the proportion that had at least one medical event due to excessive heat in their home.

Results

The results for the economic and health index by IOU and Segment are discussed below. First, descriptive statistics and response distributions are presented, followed by the results from the RCT comparison of control and TOU Rate treatment groups.

Economic Index

The average economic index scores across the IOUs and key customer segments ranged from 2.14 to 4.04 (Table 4). Scores can range from 0 to 10, and a higher score indicates greater economic difficulty. Average scores are mostly consistent across IOUs and, as expected, are substantially higher for the low-income CARE/FERA customers than the non-CARE/FERA customers.

Table 4. Measures of Central Tendency for Economic Index, by IOU and Key Customer Segments[1]

IOU & Segment	Mean	25th Percentile	Median	75th Percentile
PG&E				
Non-CARE/FERA	2.14	1.05	1.70	2.82
CARE/FERA	3.98	2.56	3.89	5.32
Total Sample	2.94	1.42	2.49	4.24
SCE				
Non-CARE/FERA	2.28	1.14	1.83	3.08
CARE/FERA	4.04	2.63	3.97	5.34
Total Sample	3.02	1.47	2.63	4.35
SDG&E				
Non-CARE/FERA	2.31	1.14	1.85	3.13
CARE/FERA	4.01	2.54	3.94	5.38
Total Sample	3.00	1.47	2.58	4.32

[1] Higher means = greater economic difficulty

As shown in Figures 2 to 4, the distribution of economic index scores is different for CARE/FERA and non-CARE/FERA groups across all three IOUs. Both groups show a large spread of economic index scores, but the distribution of CARE/FERA scores is normally distributed while the distribution of non-CARE/FERA scores positively skewed toward the low end of the index.
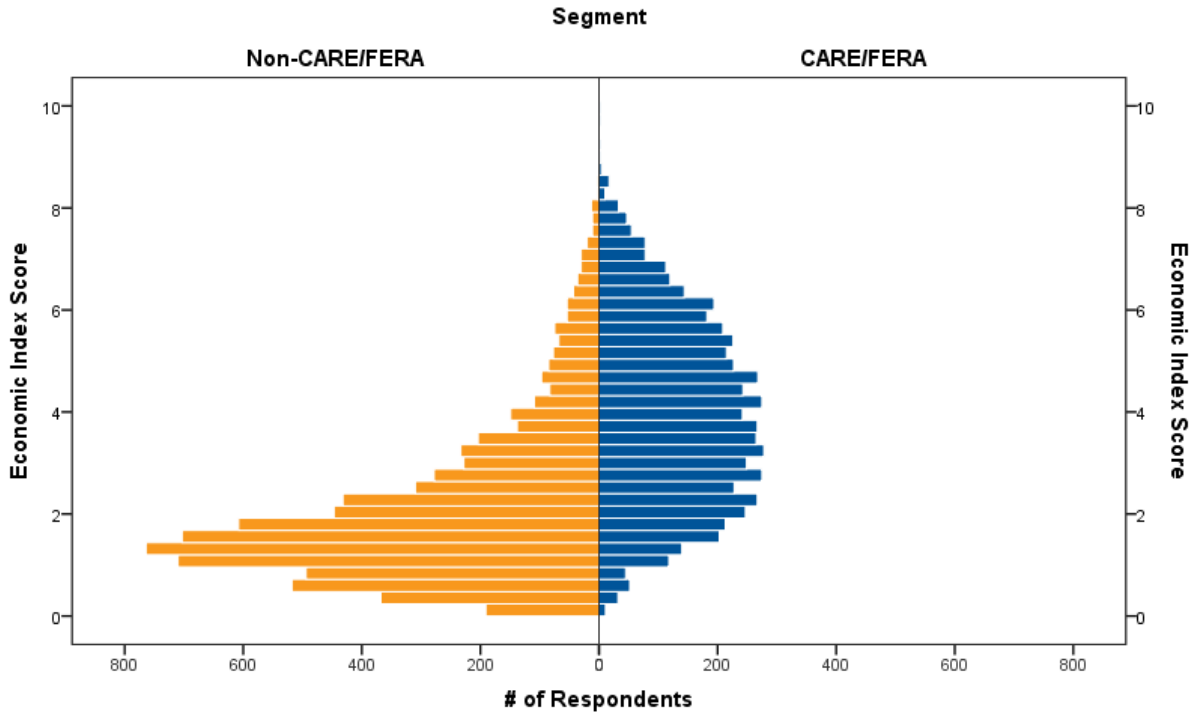
Figure 2. Histogram of Economic Index Scores For PG&E CARE/FERA and Non-CARE/FERA Segments (n=10,331)[1]

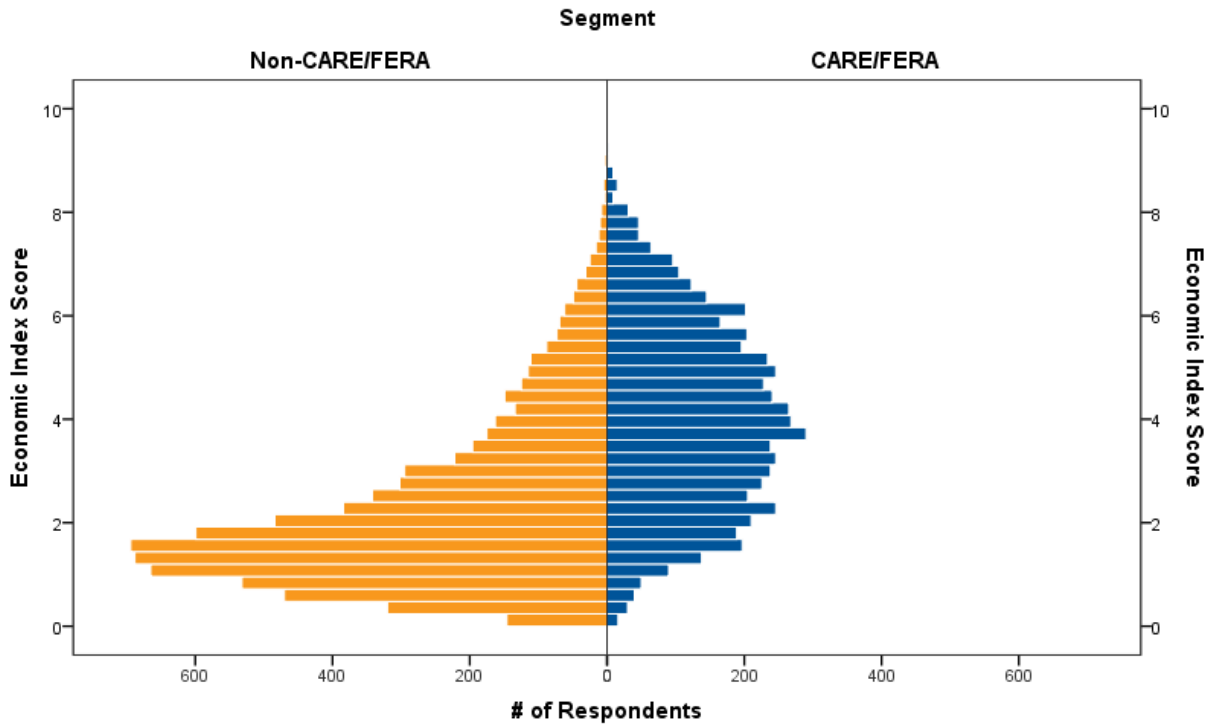[1] Higher means = greater economic difficulty

Figure 4. Histogram of Economic Index Scores For SCE CARE/FERA and Non-CARE/FERA Segments (n=12,033)[1]

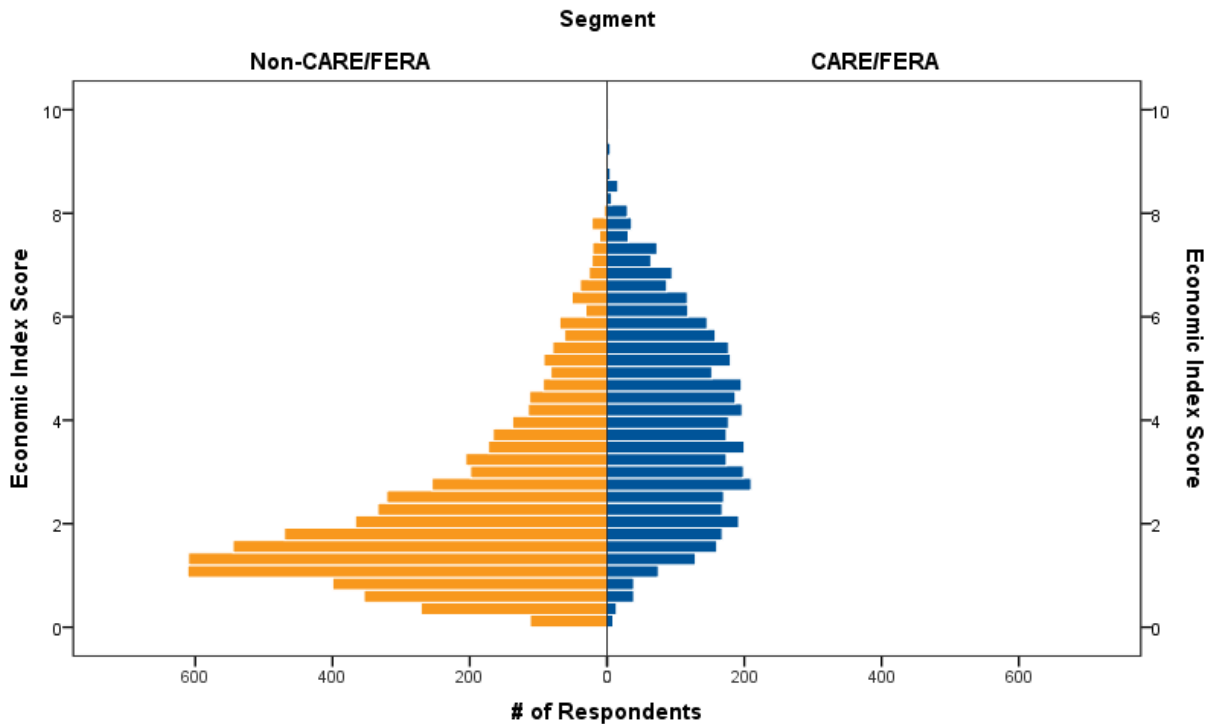[1] Higher means = greater economic difficulty

Figure 4. Histogram of Economic Index Scores For SDG&E CARE/FERA and Non-CARE/FERA Segments (n=10,528)[1]

[1] Higher means = greater economic difficulty

To assess whether the TOU rates caused economic difficulties, differences in average economic index scores were compared between the Control and Rate groups using a two-tailed t-test (Tables 5 to 7). As shown in Table 5, there were no statistically significant differences between Control and Rate customers across any of PG&E's 18 rates/segments/regions (Table 5).

Table 5. Comparison of Economic Index Means, PG&E[1,2]

Climate Region	Segment	Control		Rate 1		Rate 2		Rate 3	
		N	Mean	N	Mean	N	Mean	N	Mean
Hot	Non-CARE/FERA	672	2.4	624	2.5	469	2.6	470	2.4
	CARE/FERA	339	4.3	332	4.4	394	4.4	398	4.5
Moderate	Non-CARE/FERA	470	2.1	462	2.0	490	2.0	454	2.0
	CARE/FERA	322	3.8	322	4.0	309	4.0	330	3.9
Cool	Non-CARE/FERA	548	1.9	535	1.8	547	1.9	510	1.9
	CARE/FERA	351	3.7	336	3.7	341	3.7	306	3.7

[1] Higher means = greater economic difficulty

[2] Two-tailed t-test used to compare means; asterisks (*) indicate significant difference at p≤.05.

One of SCE's 18 rates/segments/regions had significantly higher average economic index scores compared to Control groups. SCE CARE/FERA customers on Rate 3, the most complex TOU rate, reported significantly greater economic difficulty compared to corresponding Control group customers (Table 6). The Rate caused a 3-tenth increase in the economic index for these groups, which is equivalent to a Rate customer noting they had trouble paying one additional bill or taking an additional action to reduce their bills compared to the Control customer during the 4-month study period.

Table 6. Comparison of Economic Index Means, SCE[1,2]

Climate Region	Segment	Control		Rate 1		Rate 2		Rate 3	
		N	Mean	N	Mean	N	Mean	N	Mean
Hot	Non-CARE/FERA	1162	2.4	740	2.3	822	2.5	424	2.6
	CARE/FERA	578	4.1	417	4.1	514	4.2	331	**4.4***
Moderate	Non-CARE/FERA	521	2.3	497	2.4	485	2.2	474	2.4
	CARE/FERA	389	4.0	367	3.8	372	3.8	310	3.9
Cool	Non-CARE/FERA	583	2.0	575	2.1	576	2.1	481	2.1
	CARE/FERA	375	3.9	352	3.9	378	3.9	310	3.9

[1] Higher means = greater economic difficulty

[2] Two-tailed t-test used to compare means; asterisks (*) indicate significant difference at p≤.05.

Three of SDG&E's eight rates/segments/regions had significantly lower average economic index scores compared to Control groups. SDG&E non-CARE/FERA customers on Rates 1 and 2 in the moderate region and on Rate 1 in the cool region reported significantly lower economic difficulty compared to corresponding Control group customers (Table 7). For these customers, the Rates caused a 3-tenth decrease in the economic index.

Table 7. Comparison of Economic Index Means, SDG&E[1,2]

Climate Region	Segment	Control		Rate 1		Rate 2	
		N	Mean	N	Mean	N	Mean
Moderate	Non-CARE/FERA	824	2.6	806	**2.4***	1382	**2.5***
	CARE/FERA	575	4.1	545	4.2	947	4.1
Cool	Non-CARE/FERA	885	2.2	868	**2.0***	1447	2.1
	CARE/FERA	626	4.0	600	3.9	1023	3.8

[1] Higher means = greater economic difficulty

[2] Two-tailed t-test used to compare means; asterisks (*) indicate significant difference at p≤.05.

Health Metric

To assess whether the TOU rates caused health difficulties, differences in the proportion of customers with a disabled household resident(s) and AC in the home who reported a medical event due to excessive heat in their home were compared between the Control and Rate groups using a two-tailed z-test (Tables 8 to 10). However, the statistical results from comparisons of many of the IOUs' customer segments in the moderate and cool regions are not valid due to small sample sizes (see notes in Tables 8 to 10).

Overall, across all IOUs, more CARE/FERA customers, on average, reported a medical event than non-CARE/FERA customers. There were no statistically significant differences between Control and Rate

customers across any of PG&E's 18 rates/segments/regions with large enough sample sizes to compare statistically (Table 8).

Table 8. Comparison of Health Metric Proportions, PG&E[1,2]

Climate Region	Segment	Control		Rate 1		Rate 2		Rate 3	
		N with AC and disabled	% with Event	N with AC and disabled	% with Event	N with AC and disabled	% with Event	N with AC and disabled	% with Event
Hot	Non-CARE/FERA	95	19%	57	14%	45	16%	41	24%
	CARE/FERA	100	25%	96	24%	82	17%	73	19%
Moderate[3]	Non-CARE/FERA	29	7%	14	7%	14	29%	25	4%
	CARE/FERA	35	14%	37	24%	31	29%	33	21%
Cool[3]	Non-CARE/FERA	4	25%	3	33%	2	0%	5	0%
	CARE/FERA	12	33%	17	35%	14	36%	14	29%

[1] Tables shows number of respondents who reported someone in their household had a disability that required they keep their home cool during the summer and had air conditioning (AC) in their home, and the percentage of those who reported a household member sought medical attention due to excess heat.

[2] Two-tailed z-test used to compare proportions; asterisks (*) indicate significant difference at p≤.05.

[3] The statistical outcomes of comparisons of groups in these regions are not valid due to small sample sizes.

Two of SCE's 18 rates/segments/regions had significantly higher proportions of customers with medical events compared to Control groups. A significantly higher proportion of SCE CARE/FERA customers on Rates 1 and 3, the most complex rates, in the hot region reported a medical event compared to corresponding Control group customers (Table 9).

Table 9. Comparison of Health Metric Proportions, SCE[1,2]

Climate Region	Segment	Control		Rate 1		Rate 2		Rate 3	
		N with AC and disabled	% with Event	N with AC and disabled	% with Event	N with AC and disabled	% with Event	N with AC and disabled	% with Event
Hot	Non-CARE/FERA	150	13%	103	14%	135	9%	84	12%
	CARE/FERA	175	18%	**127**	**31%***	159	26%	**97**	**29%***
Moderate	Non-CARE/FERA[3]	57	18%	73	19%	53	9%	52	12%
	CARE/FERA	107	22%	101	23%	102	31%	80	25%
Cool	Non-CARE/FERA[3]	45	16%	35	23%	42	14%	30	30%
	CARE/FERA[3]	66	32%	60	18%	53	26%	47	28%

[1] Tables shows number of respondents who reported someone in their household had a disability that required they keep their home cool during the summer and had air conditioning (AC) in their home.

[2] Two-tailed z-test used to compare proportions; asterisks (*) indicate significant difference at p≤.05.

[3] The statistical outcomes of comparisons of groups in these regions are not valid due to small sample sizes.

Samples sizes for SDG&E's rate groups and customer segments were too small for statistically valid comparisons. Trends indicate that a similar proportion of CARE/FERA customers in the Rates and Control groups reported a medical event and a higher proportion of non-CARE/FERA customers in the Rate groups (except Rate 2 in the moderate region) reported a medical event compared to Control group customers (Table 10).

Table 10. Comparison of Health Metric Proportions, SDG&E[1,2,3]

Climate Region	Segment	Control		Rate 1		Rate 2	
		N with AC and disabled	% with Event	N with AC and disabled	% with Event	N with AC and disabled	% with Event
Moderate	Non-CARE/FERA	15	13%	14	29%	28	7%
	CARE/FERA	26	35%	20	40%	41	37%
Cool	Non-CARE/FERA	13	23%	10	30%	25	36%
	CARE/FERA	23	48%	22	45%	30	27%

[1] Tables shows number of respondents who reported someone in their household had a disability that required they keep their home cool during the summer and had air conditioning (AC) in their home.

[2] Two-tailed z-test used to compare proportions; asterisks (*) indicate significant difference at p≤.05.

[3] The statistical outcomes of comparisons of groups in these regions are not valid due to small sample sizes.

Conclusions

We offer four conclusions from this research: two have broad implications for energy program evaluation in general, and two pertain specifically to this research.

First, it is imminently feasible to obtain high participation rates in surveys using mixed mode strategies with high incentives. We targeted a census for survey completion, and achieved an 82% response rate. Yes, it was expensive, both in terms of the need to include mail and phone with web administration, and the payment of substantial incentives. Yet, the web mode alone achieved 81% of respondents, and only a very small percentage of customers (0.6%) received a bill credit larger than $50.

Second, the economic indicator appears to be effective in providing a metric of economic effects on customers during a cooling season. The index requires just four questions and places minimal burden on respondents. This index could be of high value to the energy industry, where most demand response and rate programs target changes in behavior during the cooling season.

Third, the economic and health indicators revealed a range of responses to the TOU rates across different rate structures and different geographic and demographic characteristics. While extreme responses were rare (0 and 10), there were differences between customers in the control group and the TOU rate treatments for some groups. For example, the Rates caused a 3-tenth increase in the economic index for two customer segments, which is equivalent to a Rate customer noting they had trouble paying one additional bill or taking an additional action to reduce their bills compared to the Control customer during the 4-month study period.

Fourth, this research demonstrates that for most customers, TOU rates do not increase economic index scores. However, a few of the most vulnerable population groups who experienced the most complicated TOU rates and live in the hot climate zone evidenced an increase in the economic index (for one rate at one utility) or health metric (two rates for one utility). Thus, ongoing attention to these affects with TOU rates is warranted.