SBW Consulting, Inc.
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FINAL REPORT
(Revision 1)

1994 Commercial HVAC Impact Evaluation

Submitted to

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Executive Summary

This study evaluated the gross and net energy savings from commercial HVAC measures which were paid rebates in 1994 through Pacific Gas and Electric Company's (PG&E) retrofit energy efficiency programs. This research was designed to satisfy PG&E's regulatory requirement to provide ex post measurements of program impact and to provide information which could be used to improve the design and operation of future programs. The products of this research include engineering and statistical estimates of gross electric consumption, electric peak demand, and gas consumption savings, as well as statistical estimates of net electric consumption and peak demand impacts. Estimates of program impact were based upon data collected from random samples of program participants and non-participants via on-site surveys, short-term end-use metering, and telephone surveys.

A. Background

PG&E offers rebates to commercial customers who adopt energy-efficient measures that reduce HVAC energy consumption and demand in existing buildings. In 1994, 1,434 customer applications were approved for rebates through the Retrofit Express and Retrofit Customized Programs covered by this evaluation. The goal of this evaluation was to determine the load impacts associated with PG&E's investment in these measures.

B. Methodology

A random sampling of 450 program participants was selected from the program data base of paid 1994 items. From the commercial customer billing files, 450 non-participants were randomly selected. The data collected from these samples provided the information needed for the gross and net impact evaluation models. The data flow for these models is illustrated in Figure Exec-1.

Methods for Estimating Gross Impact

Two methods were used to estimate gross impacts. These method are described below.

1. **Engineering Analysis of Gross**. Data for the engineering analysis were collected via on-site surveys and end-use metering for 139 participants. Participants were split into 60 "cluster" and 79 "matched-pair sites", all of which were modeled in DOE 2.1E to simulate energy consumption and estimate savings. Cluster sites received a detailed survey and were calibrated to monthly bills. Less detailed on-site surveys and DOE 2.1E modeling was completed for matched pair sites. For measures affected by Title 20 standards, an additional estimate of savings was calculated presuming a Title 20 baseline standard. Additional models were also developed to analyze the interaction between energy-efficient lighting and HVAC. The methodology for the cluster and matched-pair analyses are summarized below:

   Data from the 60 cluster analysis surveys were reviewed and used to define five clusters of similar sites, based on a variety of factors such as building type, size, thermal zoning, envelope characteristics and HVAC system type. The objective was to create clusters that had similar simulation modeling features. A fully calibrated simulation was created for one site in each cluster, and variations on that model were run to estimate the base and efficient energy use of the HVAC measures installed in each of the other sites in the cluster. The glazing characteristics, internal loads and HVAC system characteristics were changed for each model. Efficient case consumption for each site was calibrated to utility billing records for a calibration period extending from June 1994 to May 1995. The gross impact of the program measures sampled at each site was calculated as the difference between base and efficient case consumption under typical weather conditions.

Data from 79 matched-pair on-site surveys were used to select the most similar cluster analysis site. This selection was based on factors such as building type, conditioned floor area, envelope characteristics, and HVAC system type. Efficient post-period use (gas and electric) was estimated for each matched-pair site by modifying simulation inputs, prepared for its paired cluster analysis site, and scaling consumption by floor area. These modifications reflected the as-built condition observed at the matched-pair site for certain key variables. The gross impact of the program measures sampled at each site were calculated as the difference between base and efficient case consumption under typical weather conditions.

2. **Statistical Analysis of Gross**.Various types of cross-sectional time-series model were estimated beginning with a pool of 438 program participants who completed the telephone survey and whose data survived a variety of data screening activities. This pool also included 138 customers for which on-site surveys were completed. An important goal of this modeling effort was to use the best information available at the lowest level of aggregation.

   The first specification incorporated separate engineering priors for HVAC installations. The advantage of this approach is that it attempted to use as much prior engineering information as possible. The information included the *enhanced* engineering priors provided by the engineering analysis as well as the engineering priors from the PG&E Program Database for measures not treated in the engieering analysis. In order to reduce the measurement error associated with this second set of priors, they were improved using information gathered from the on-site surveys. The second specification, referred to as a *mixed* specification, used the enhanced engineering priors and dummy variables representing the other installations that did not received new engineering analysis. This was done because there remained some concern regarding the amount of measurement error contained in these improved priors. This third model incorporated dummy variables indicating the installation of HVAC equipment. All three models included a variety of other data such as on-site and telephone survey data, data from the PG&E Program Database, economic data, and weather data. Neither the SAE nor the mixed models performed well. The third model performed best and was used to develop the final statistical gross results.

Methods for Estimating Net Impact

Net-to-gross ratios were estimated using three different methods, each of which is described briefly below:

1. **Participant Self-Report Analysis of NTG Ratio:** Telephone interviews of 450 participants were conducted to obtain self-reports on the effect of the rebates on the installation of energy efficient HVAC measures. The intent was to interview the person who played a role in the decision to participate in the program. This approach used stated intentions regarding the role played by the rebate in installing efficiency measures combined with additional consistency checks that override stated intentions where appropriate. The resulting net-to-gross ratio was weighted by avoided energy and capacity costs.

2. **Discrete Choice Analysis of NTG Ratio**: A nested logit model, using data from 438 participants and 442 nonparticipants, was used to estimate a net-to-gross ratio. The unit of analysis for this mode was the premise. The nested logit modeling system recognizes the correlations in unobserved factors over different options available to any given customer. This approach also controls for self-selection bias.

3. **Billing Regression Analysis of NTG Ratio** : For this method, a non-equivalent control group design was used to estimate net savings. This analysis compared billing histories associated with a sample of 438 participants and 442 nonparticipants. Modeling was conducted at the premise level. This method took participants who self-selected into the program and compared their electric consumption with that for nonparticipants. Because these two groups are, in practice, never equivalent, their differences were controlled for statistically. A NTG ratio was computed for this method by dividing the net savings estimate by the statistical estimate of gross saving.

C. Results

The methods described above were used to estimate gross and net savings for the 1994 paid HVAC measures. The results of these analyses are summarized below.

Gross Savings Estimates

Table Exec-1 provides estimates of savings realization rates, based on engineering gross estimates, for the both the 1994 program as a whole and for the Retrofit Express and Retrofit Customized components. Electric and gas savings estimates from the PG&E program data base are compared with engineering savings estimates for each program and overall. This table also includes the relative error of the engineering estimates at the 90% confidence level, as well as the corresponding confidence interval, so that the statistical significance of the results can be evaluated.

As shown in Table Exec-1, engineering the realization rates for total GWh savings, MW savings, and kTherm savings are 0.76, 1.16, and 1.78, respectively. The realization rates indicate that the overall programs saved more MW and kTherm than expected, but somewhat fewer GWh than originally predicted. In general, the Retrofit Customized Program showed higher realization rates than the Retrofit Express Program: for instance, the GWh realization rate for Customized was 0.90, compared to 0.59 for Express.

Table Exec-2 shows engineering estimates of GWh savings and realization rates broken down by HVAC measure, assuming baseline conditions meeting Title 20 limits. GWh realization rates for each measure varied dramatically. They tended to be high (84%-103%) in the custom program, although the relative error was correspondingly high because of the small number sampled. Certain Express Program measures, most notably cooling towers (26%), evaporative coolers (7%), and reflective window film (30%), had especially poor GWh realization rates. For these three measures, the program data base consistently overstated estimated savings.

The effect of Title 20 standards on savings estimates was also examined as part of the engineering analysis. These standards only affected central air-cooled air conditioning units, such as packaged direct expansion cooling units and heat pumps. Overall, removing the Title 20 constraints and using the conditions prior to installing the HVAC measure as a baseline increased program electric consumption (GWh) savings estimates by 2%, electric peak demand (MW) estimates by 13%, and gas consumption (kTherm) estimates by 18%. On an absolute basis, the program savings estimates for electric usage, demand, and gas usage increased by 1.18 GWh, 2.29 MW, and 174.3 kTherms, respectively, without the Title 20 limits.

Both the engineering and statistical estimates of gross savings and realization rates are summarized in Table Exec-3 below. The statistical gross savings analysis yielded a gross realization rate for annual energy consumption (the ratio of evaluation gross savings to program gross savings) of 0.92. The engineering analysis found that the primary reason for differences between program and evaluation savings estimates was discrepancies in assumed operating hours, rather than differences in equipment capacity. The engineering analysis, because it estimates demand more or less independently of operating hours, should yield a more accurate realization rate. Because of this, the statistical gross realization rate was adjusted upwards to 1.09 for MW to bring it in line with the engineering MW realization rate of 1.16.

The engineering analysis of the effect of lighting on HVAC savings overall found the effect to be very small. Of the 173 HVAC items associated with the 139 participants in the engineering sample, 70 were associated with billing control numbers that received 1994 lighting rebates. In 48 of these cases there was overlap between areas affected by the lighting and the HVAC measures. For these 48 cases, the GWh, MW, and kTherm savings increased with efficient lighting by 1.70%, 2.17%, and 0.34%, respectively. For the program overall, GWh, MW, and kTherm savings increased 0.35%, 0.27%, and 0.77%, respectively. Savings increased, rather than decreased, because of the significant effect of HVAC fan measures, which typically show greater HVAC savings with reduced lighting loads. These fan measures showed an increase of savings of 3.6% with efficient lighting, more than offsetting the 3.2% reduction in savings for other lighting-affected HVAC measures.

The statistical analysis of the lighting/HVAC interaction did not yield a statistically significant estimate of the interaction effect. Despite the relatively large sample size the billing regression model was unable to quantify the effect.

Net Savings Estimates

The net-to-gross ratios for the self-report and discrete-choice analyses were 0.57 and 0.55, respectively. To calculate the net-to-gross ratio for the billing regression analysis, billing regression net savings were divided by the statistical gross savings, yielding a net-to-gross ratio of 0.70. The three net-to-gross ratios were applied to both the GWh and MW billing regression estimates of gross savings to estimate net savings. The corresponding net GWh realization rates (defined as the evaluation estimate of net savings divided by the program estimate of net savings) were 0.73, 0.71, and 0.90, respectively.

While the three NTG ratios shown in in Table Exec-3 are not statistically different, they were produced by very different approaches, each with its own set of advantages and disadvantages. This is a classic case of triangulation in which the uncertainty surrounding a given estimate is reduced by obtaining additional points of comparison using complementary techniques. Thus, in the current study, while the uncertainty surrounding the individual estimates can be quite large, the uncertainty surrounding the "true" estimate is reduced by virtue of the strong agreement among the three estimates. These three estimates can be said to converge on the "true" estimate. Although the M&E Protocols do not allow NTG ratios based on self-reports, these NTG ratios can be used to provide a sanity check on those methods that are allowed by the Protocols. The self-report-based NTG ratio of 0.57 has clearly provided such a sanity check. While the discrete choice model, which examined the choices made by customers, was a somewhat unstable model, it did arrive independently at an estimate that was reasonably close to the other two. The billing regression analysis produced the highest estimate but one that was still close to the two NTG ratios used for the Customized and Express Programs.

Figure Exec-1: Data Flow for Impact Analysis

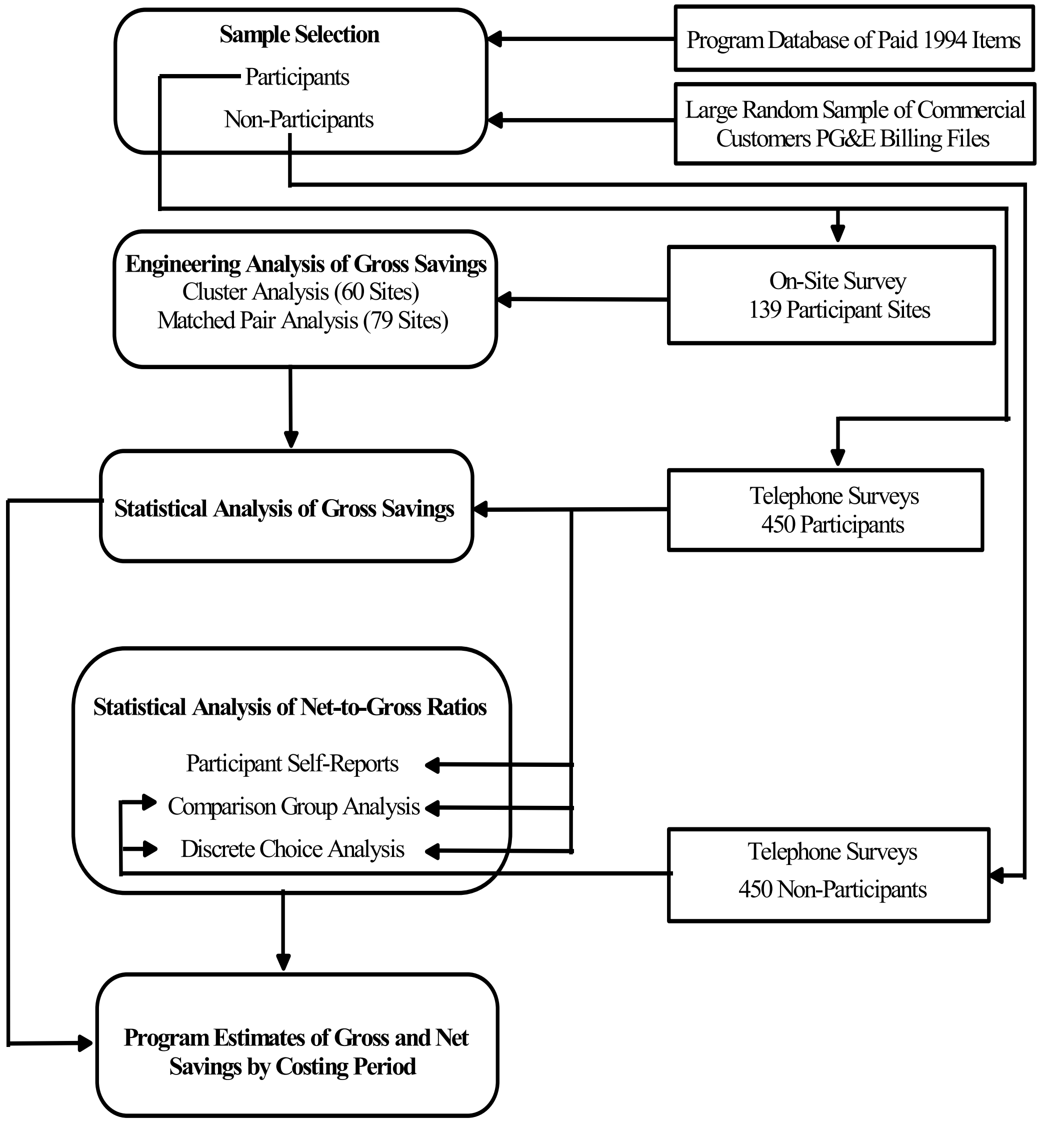


Table Exec-1: Engineering Estimates of Gross Savings Realization Rates

Program	PG&E Data Base Savings	Evaluated Savings	Percent Change	RE @ 90% CL	Realization Rate
Retrofit Customized					
Electric Usage (GWh)	35.46	31.96	-9.9	28.2	**0.90**
Electric Demand (MW)	2.64	9.18	248	23.1	**3.48**
Gas Usage (kTherm)	544.85	814.40	49.5	49.0	**1.49**
Retrofit Express					
Electric Usage (GWh)	29.64	17.40	-41.3	17.4	**0.59**
Electric Demand (MW)	12.70	8.57	-32.5	20.8	**0.67**
Gas Usage (kTherm)	0.00	156.81	--	97.3	**--**
TOTAL					
Electric Usage (GWh)	65.10	49.36	-24.2	19.3	**0.76**
Electric Demand (MW)	15.34	17.75	15.7	15.6	**1.16**
Gas Usage (kTherm)	544.85	971.21	78.3	44.0	**1.78**

RE @ 90% CL (relative error at 90% confidence level) applies to evaluated savings.

Table Exec-2: Engineering Gross kWh Savings Realization Rates by Program and Measure

		GWh Savings			
Program	**Domain**	**PG&E Data Base Values**	**Evaluated**	**Realization Rate**	**RE @ 90% CL**
Custom		**35.46**	**31.96**	**0.90**	**28.25**
	Convert to VAV	3.23	3.01	0.93	**71.53**
	Gas Absorption A/C	0.00	0.00	--	**0.00**
	HVAC Adjustable Speed Drive	4.99	4.27	0.85	**49.33**
	HVAC Resize Motor/Compressor	9.35	9.66	1.03	**84.11**
	Install HVAC EMS	17.88	15.02	0.84	**16.84**
Express		**29.64**	**17.40**	**0.59**	**17.40**
	A/C: Central Air Cooled	1.58	1.02	0.65	**23.94**
	Adjustable Speed Drive: HVAC Fan 50 HP	2.66	5.66	2.13	**39.15**
	Cooling Tower	4.56	1.20	0.26	**33.42**
	Evaporative Cooler	2.65	0.20	0.07	**54.78**
	Other	6.91	2.49	0.36	**55.29**
	Reflective Window Film	3.00	0.90	0.30	**40.19**
	Water Chiller Air Cooled	3.70	1.92	0.52	**42.34**
	Water Chiller Water Cooled	4.59	4.01	0.87	**28.84**
Total		**65.10**	**49.36**	**0.76**	**19.29**

Table Exec-3: Summary of Program-Level Evaluation Results

	Electric Usage		**Electric Demand**		**Gas Usage**	
	GWh/yr (9)	90% CI (1)	MW (9)	90% CI (1)	kTherms/yr (9)	90% CI (1)
PG&E's PROGRAM DATA BASE						
Gross Savings	**65.10**	--	**15.34**	--	**544.9**	--
Net-to-Gross Ratio (2)	**0.71**	--	**0.68**	--	**0.75**	--
Net Savings	**46.45**	--	**10.49**	--	**408.6**	--
EVALUATION RESULTS						
Gross Realization Rate (3)						
Engineering	**0.76**	0.61 to 0.90	**1.16**	0.98 to 1.34	**1.78**	1.00 to 2.57
Statistical	**0.92**	0.72 to 1.12	**1.09 (4)**	--	--	--
Gross Savings						
Engineering	**49.36**	39.8 to 58.9	**17.75**	15.0 to 20.5	**971.2**	544 to 1398
Statistical	**59.89**	47.1 to 72.7	**16.77**	--	--	--
Net-to-Gross Ratio						
Self-Report	**0.57**	0.32 to 0.82 (5)	**0.57**	0.32 to 0.82 (5)	**0.57**	--
Discrete Choice	**0.55**	0.23 to 0.87	**0.55**	0.23 to 0.87	**0.55**	--
Billing Regression	**0.70**	-4.1 to 5.5	**0.70**	-4.1 to 5.5	**0.70**	--
Net Savings (6)						
Self-Report	**34.14**	--	**9.56**	--	**553.6 (8)**	--
Discrete Choice	**32.94**	--	**9.22**	--	**534.2 (8)**	--
Billing Regression	**41.92**	--	**11.74**	--	**679.8 (8)**	--
Net Realization Rate (7)						
Self-Report	**0.73**	--	**0.91**	--	**1.35**	--
Discrete Choice	**0.71**	--	**0.88**	--	**1.31**	--
Billing Regression	**0.90**	--	**1.12**	--	**1.66**	--

NOTES

1. Confidence interval (CI) at a 90% confidence level.
2. Assumes a net-to-gross ratio of 0.75 for Customized Program measures, 0.67 for Express Program measures.
3. Evaluation gross savings / program gross savings.
4. The statistical gross realization rate of 0.92 was adjusted upwards towards the engineering MW realization rate of 1.16 since the major reason for program/evaluation discrepancies was a difference in assumed operating hours.
5. This is an uncertainty range, rather than a confidence interval.
6. Based on statistical gross savings estimates.
7. Evaluation net savings / program net savings.
8. Estimates of net therm savings were derived by multiplying electrical net-to-gross ratios and the engineering estimate of gross savings.
9. These units apply to all number below except for realization rates and net-to-gross ratios.

I. Introduction

Pacific Gas and Electric offers rebates to its commercial customers for the adoption of energy-efficient measures that reduce HVAC energy consumption and demand in existing buildings. In 1994, rebates for HVAC Efficiency Measures were provided by PG&E's Retrofit Express and Customized Programs. In 1994, PG&E paid out rebates for commercial-sector HVAC projects through 1,434 customer applications. Measures included technologies such as high-efficiency chillers and packaged air conditioners, HVAC adjustable speed drives, conversions to variable air volume (VAV) systems, reflective window film, cooling towers, resized HVAC motors and compressors, energy management systems (EMS), and programmable thermostats. The research documented in this report was undertaken to determine the gross and net energy and demand impacts associated with PG&E's investment in these measures. This report presents the methodology and results of the evaluation of PG&E's 1994 Commercial HVAC Retrofit Measures.

A. Research Objectives

The objectives of this evaluation were to:

- Determine the first-year gross impacts (kW, kWh, and therms) of the 1994 commercial HVAC measures installed through PG&E's Retrofit Customized and Express incentive programs. Both engineering and statistical gross impacts were developed.

- Determine the first-year net impacts (kW and kWh) of the 1994 commercial HVAC measures installed through PG&E's Retrofit Customized and Express incentive programs. Three different statistical methods for determining the net-to-gross (NTG) ratio were used.

- Identify the basis for discrepancies between the evaluation results and PG&E's estimates of program impact.

B. Unit of Analysis

A wide variety of data have been collected to support the engineering and statistical estimates of gross and net savings presented in this report. These data provide information for a number of different units of analysis associated with participant and nonparticipant customer sites. These units of analysis are defined as follows:

- **Control Number**. When electrical service is established at a new location, a meter base is installed. PG&E assigns a permanent control number to this meter base. Over time one or more meters may be installed to measure electrical energy supplied through the meter base. The electric and gas billing histories used in the evaluation were tied to a specific control number.

- **Account**. Meter bases and meters are installed in response to a request for service by a customer. Once installed, an account is established for the purpose of billing the customer for electrical energy use and demand, as recorded by the installed meters. For most customers, at any one point in time, there is a one-to-one relationship between accounts, meters, and control numbers. Over time, different customers may establish new accounts to purchase electricity through the meters associated with a control number, i.e., mounted on a specific meter base.

- **Premise**. A premise can be loosely defined as all of the facilities belonging to a customer at a given location (within approximately a city block). The same premise identification number is assigned to all of the control numbers linked to meters serving a single customer at a single location. All statistical analyses were performed at the premise level. A further discussion of the exact definition of a premise and the methodology used to identify them can be found in Appendix C.

- **Application**. PG&E's HVAC retrofit programs provide incentives after processing is complete for an application submitted by a commercial customer. As each application is processed, an application file is created. PG&E's program data base maintains information from these application files in electronic form. One or more application files may be processed for the same customer at a single location. Some applications cover measures installed at more than one location controlled by the same customer. Each application file is assigned an application number and a program year. Program year refers to the year of the program's operation under which the application was received, not the year that the rebate was paid. Thus, the paid applications which were the subject of this evaluation include applications received during 1992, 1993, and 1994.

- **Item**. Each of the application files describes energy efficiency measures paid for by the program. Each type of equipment, e.g., energy management system or cooling tower, installed at a specific customer location, is referred to as an "item" in the MDSS data base. Each item is assigned a measure code in the data base to indicate the type of equipment involved. Each item is assigned to a control number, indicating the PG&E meter that was affected by the equipment's installation. However, more than one item may be assigned to the same control number. It is also possible that an item affects more than one control number, even though the program data base allowed for only one. PG&E also refers to items as "projects."

- **Site**. For the sample of participants in this evaluation, a site is synonymous with control number, i.e., the site is the portion of a customer's facility which is supplied electricity by the PG&E meter assigned to one or more items in the program data base. If a selected item affects more than one electric meter, the site will be the union of the area served by the affected meters. If gas usage is affected, the site will be the union of the area served by the affected electric and gas meters.

- **Cluster Sites**. A category of participating sites in the engineering sample that are grouped according to common characteristics. The most detailed level of DOE 2.1E modeling is applied in the analysis of savings from cluster sites.

- **Calibration Site**. A single site, selected from each cluster, for which a detailed calibrated DOE 2.1E model is developed. These calibrated models are subsequently modified to model each of the Test and Other Clustered Sites in their respective clusters. Short-term end-use metering is conducted at these sites.

- **Test Site**. Single sites, selected from three clusters, that are used to test the impact of site specific envelope data on the estimate of savings for cluster sites. These sites are calibrated twice: as though they were a calibration site (except for end use metering) and as though they were a matched-pair site.

- **Other Clustered Sites**. The balance of the sites in a cluster that are not calibration or test sites.

- **Matched-Pair Sites**. A category of participating sites in the engineering sample that are not included in the cluster analysis of savings. Savings for these sites are computed by selecting the most similar cluster site and modifying that site's DOE 2.1E model to reflect the measure characteristics of the matched-pair site.

C. Programs and Efficiency Measures

This impact evaluation covered two programs, the Retrofit Customized and Retrofit Express Programs. An overview of each program and the efficiency measures for each program that were included in this evaluation is provided below:

Retrofit Customized

This program offered financial incentives to customers who undertook large or complex projects that save gas or electricity. These customers had to submit calculations for the projected first-year energy savings, along with an application, prior to the start of the customers' installation of high-efficiency equipment. The maximum total incentive amount for this program was $500,000 per account. Common measures included the following:

- **Gas Absorption A/C**: Central water-cooling plant equipment powered by natural gas.

- **HVAC Resize Motor/Compressor**: Change in the size of ventilation fans or cooling equipment to achieve more efficient operation.

- **Conversion to VAV**: Conversion of constant air supply central fan system to one that varies the air supply with space heating and cooling requirements.

- **HVAC EMS**: A computer-controlled Energy Management System (EMS) to efficiently control the heating/cooling systems. The EMS may control heating and cooling temperatures, on/off schedules, and other important functions.

- **HVAC Adjustable Speed Drive**: Conversion of constant-speed pump or fan motor to one that varies the speed with changing loads.

- **HVAC Controls**: Automatic controls to efficiently operate the heating/cooling systems. These controls may regulate heating and cooling temperatures, on/off schedules, and other important functions.

- **HVAC Other**: Other miscellaneous heating/cooling related efficiency improvements.

- **Change/Add Other Equipment**: Other heating/cooling related efficiency improvements that involve changing or adding equipment.

Retrofit Express

This program offered rebates to commercial, industrial, and agricultural customers who installed air conditioning equipment that was more efficient than the equipment stipulated in the 1994 Title 20 standards. For equipment where no Title 20 standards applied, the new equipment had to exceed the standards for the most commonly used equipment in the industry. PG&E offered rebates not only for new energy efficient cooling equipment, but also for early replacement of old equipment and control technologies. Rebates were based on efficiency and size of equipment, as well as other factors such as the age of the equipment being replaced. Common measures included the following:

- **Reflective Window Film**: Reflective material on window glass to reduce the amount of sunlight entering a conditioned space.
- **A/C: Package, terminal, < 65 kBTU/hr**: High efficiency, small size packaged terminal air conditioning equipment with heat rejection fans.
- **A/C: Central Air Cooled**: High efficiency, medium to large size, packaged or split-system air conditioning equipment with heat rejection fans.
- **Water Chiller Air Cooled**: High efficiency central water cooling plant equipment with heat rejection fans.
- **Water Chiller Water Cooled**: High efficiency central water cooling plant equipment with a heat rejection cooling tower.
- **Cooling Tower**: High efficiency cooling tower for rejecting heat from central water cooling plant equipment.
- **Evaporative cooler**: A swamp cooler, instead of an air conditioner, used for space cooling.
- **Adjustable Speed Drive: HVAC Fan, 50 hp max.:** Conversion of a constant air flow fan, up to 50 horsepower maximum, to one that varies the air flow in response to changing loads.
- **Thermostat: Setback Programmable**: A thermostat that can be programmed to automatically adjust temperatures in a conditioned space depending on the time of day or day of week.

II. Overview of Research Design

This section provides an overview of the research design for this impact evaluation. Later sections provide detailed descriptions of various aspects of the research design.

A. Study Population and Domains

The goal of this study was to evaluate the impact of the 1994 Commercial HVAC retrofit program. The study population consists of those 2,108 items included in applications with paid dates during 1994. However, by agreement with PG&E, 15 measures, which account for 104 items, have been eliminated from the study population. Collectively, these measures account for less than 5 percent of the kWh, kW, or therm savings, or the shareholder benefits, as listed in the program data base. In addition, items for which it was not possible to construct an adequate billing history of pre-retrofit electrical consumption were removed from the study. Finally, a small group of applications associated with sensitive customers identified by PG&E were also removed. The remaining study population consists of 1,646 items.

In order to provide information useful for program design, the study population was divided into a series of domains of study. For each of these domains, enhanced engineering estimates of gross impact were provided. Statistical estimates of gross and net impact for these domains were also provided when possible. Twelve domains are defined by specific measure. These are collectively referred to as the High Savings Domains, as they account for more than 80 percent of the program estimates of the program's energy savings. All of the remaining measures are grouped in a single domain, referred to as the Other domain.

The statistical models used to estimate the Net-To-Gross (NTG) ratio require a non-participant sample. This sample was drawn from the population that included all active 1994 commercial premises served by PG&E. Premises linked to control numbers associated with HVAC items paid in 1994 were excluded from the sample, as were customers deemed sensitive by PG&E and customers who were contacted for PG&E's evaluation of other retrofit measures

B. Sampling and Analysis Units

The treatment of sampling and analysis units in each phase of the research design was as follows:

Sample Selection

For the participant sample the fundamental unit was the item. A stratified random sample of items was drawn from the program data base. However, a sufficient number of items was drawn to allow for the completion of on-site surveys for 139 sites and telephone surveys for 450 sites. On average there were 1.6 items per site (control number) in the study population. For the non-participant sample, a sample of control numbers from the 1994 commercial population served by PG&E was selected.

Engineering Analysis of Gross Impact

The engineering analysis of gross impact was conducted at the item level.

Statistical Analysis of Gross Impact

For participant sites where on-site surveys are conducted the unit of analysis was the control number. For the balance of the participant sample the unit of analysis was the premise.

Statistical Analysis of Net Impact

The unit of analysis was the premise.

C. Engineering Impact Evaluation Methods

Both engineering and statistical methods were used to determine the gross impacts associated with the program. The principal features of the methodology for the engineering estimation of gross impacts are as follows:

Cluster Analysis Methodology

Cluster Analysis Survey: On-site surveys were performed for 60 cluster analysis sites. The level of survey work at each of these 60 sites was sufficient to support a cluster analysis (DOE 2.1E or equivalent complex algorithm) of savings associated with the sampled HVAC measures. During the survey, pre-conditions data were also collected for the parameters affected by program measures. Up to two high savings domain measures were surveyed per site. Data from the 60 cluster analysis surveys were reviewed and used to define five clusters of similar sites. This clustering was based on a variety of factors such as building type, size, thermal zoning, envelope characteristics and HVAC system type. The objective was to create clusters that had similar simulation modeling features. A fully calibrated simulation was created for one site in each cluster, and variations on that model were run to estimate the base and efficient energy use of the HVAC measures installed in each of the other sites in the cluster. The glazing characteristics, internal loads and HVAC system characteristics were changed for each model.

Calibration and Test Site Selection. Once the clusters were defined, one calibration site was selected from each cluster. One test site was also chosen from three of the five clusters. The calibration and test sites installed HVAC measures prior to the summer of 1994 so that the model could be calibrated to summer 1994 loads. In addition, owners and occupants of the calibration and test sites were willing to allow additional data collection at the site. When possible, the calibration site was chosen to be near the center of the cluster in terms of the characteristics that are used to define the cluster. Additional data collection activities were conducted at each of the calibration and test sites.

Cluster Analysis of Gross Impacts: The first class of engineering analysis involved the development of a simulation model (DOE-2.1E or equivalent complex algorithm) for each cluster site and the use of the model to estimate base case and efficient case consumption for each site. Efficient case consumption for each site was calibrated to utility billing records for a calibration period extending from June 1994 to May 1995. Calibration sites used the results of the short term measurements in the calibration process. The gross impact of the program measures sampled at each site was calculated as the difference between base and efficient case consumption under typical weather conditions. The cluster analysis is discussed in greater detail in Section V.

Matched-Pair Analysis Methodology

Matched-Pair Analysis Survey: On-site surveys were performed for 79 matched-pair analysis sites. The level of survey work at each of these 79 sites was sufficient to support a matched-pair analysis (DOE 2.1E or equivalent complex algorithm) of savings associated with the sampled HVAC measure(s). During the survey, pre-conditions data were also collected for the parameters affected by program measures. Up to two high savings domain measures were surveyed per site. Data from matched-pair on-site surveys were used to select the most similar cluster analysis site. This selection was based on a variety of factors, such as building type, conditioned floor area, envelope characteristics, and HVAC system type.

Matched-Pair Analysis of Gross Impacts: The second-level matched-pair engineering analysis involved the development of a simulation model (DOE-2.1E or equivalent complex algorithm) for each matched-pair site and the use of the model to estimate base and efficient case consumption for each site. The matched-pair analysis provided a less rigorous assessment of savings than that provided by cluster site analysis. In matched-pair analyses, typical efficient post-period use (gas and electric) for each matched-pair site was estimated by modifying simulation inputs prepared for its paired cluster analysis site. These modifications reflected the as-built condition observed at the matched-pair site for certain key variables. The gross impact of the program measures sampled at each site were calculated as the difference between base and efficient case consumption under typical weather conditions. The matched-pair analysis is discussed further in Section V.

Lighting/HVAC Interaction Analysis Methodology

At some of the sites subjected to an engineering analysis, rebated energy-efficient lighting measures were also installed. In many cases, these lighting retrofits affected the total cooling consumption, and thus the savings associated with the HVAC measures. Items affected by lighting rebates were identified so that field surveyors could gather additional information about the type and quantity of rebated lighting that affected the HVAC measure. This information was used to modify the original DOE 2.1E models. These new models were used to develop engineering estimates of the interaction between HVAC and lighting measure savings. Statistical analyses were also performed to quantify the effect of the interaction. The lighting/HVAC interaction analysis is discussed in more detail in Section XIII.

D. Statistical Impact Evaluation Methods

Statistical modeling techniques were used to further refine estimates of gross program savings and to prepare estimates of net-to-gross ratios. Net-to-gross ratios were estimated using three different methods. An overview of these methods is presented below.

Statistical Analysis of Gross Impact

Various types of cross-sectional time-series model were estimated beginning with a pool of 438 program participants who completed the telephone survey and whose data survived a variety of data screening activities. This pool also included 138 customers for whom on-site surveys were completed. An important goal of this modeling effort was to use the best information available at the lowest level of aggregation.

The first specification incorporated separate engineering priors for HVAC installations. The information included the *enhanced* engineering priors provided by the engineering analysis as well as the engineering priors from the PG&E Program Database for measures not treated in the engineering analysis. In order to reduce the measurement error associated with this second set of priors, they were improved using information gathered from the on-site surveys. The second specification, referred to as a *mixed* specification, used the enhanced engineering priors and dummy variables representing the other installations that did not received new engineering analysis. This was done because there remained some concern regarding the amount of measurement error contained in these improved priors. This third model incorporated dummy variables indicating the installation of HVAC equipment. All three models included a variety of other data such as on-site and telephone survey data, data from the PG&E Program Database, economic data, and weather data. Neither the SAE nor the mixed models performed well. The third model performed best and was used to develop the final statistical gross results. A more comprehensive explanation of these techniques can be found in Section VI.

Analysis of Net Impact

Three methods were used to estimate net-to-gross ratios and the associated net impacts of the HVAC efficiency measures. These three methods are described below:

Participant Self-Report Analysis of NTG Ratio: Telephone interviews of 450 participants were conducted to obtain self-reports on the effect of the rebates on the installation of energy efficient HVAC measures. The intent was to interview the person who played a role in the decision to participate in the program. This approach used stated intentions regarding the role played by the rebate in installing efficiency measures combined with additional consistency checks that override stated intentions where appropriate. The resulting net-to-gross ratio was weighted by avoided energy and capacity costs. A more comprehensive explanation of this method is provided in Section VII.

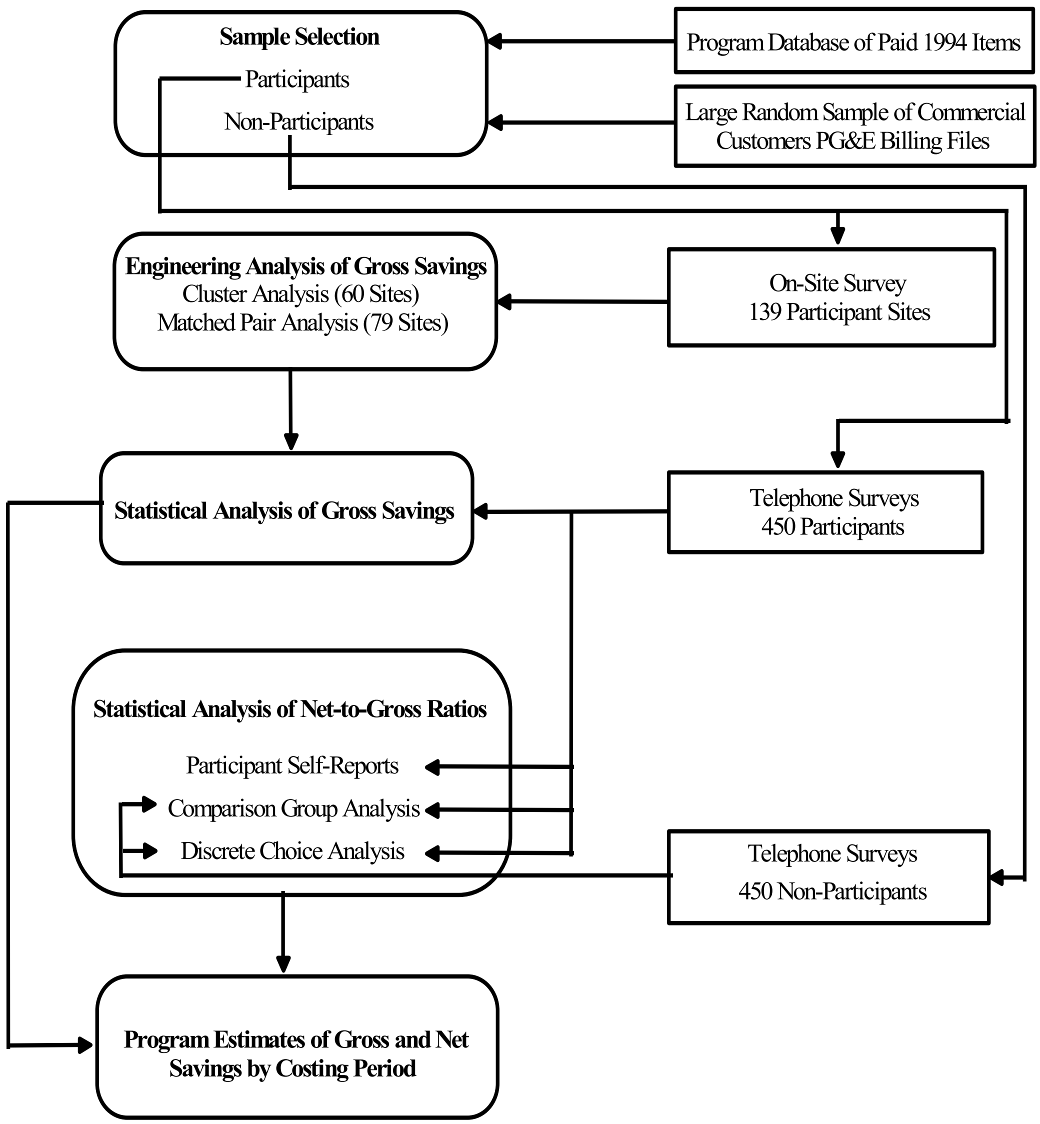
Discrete Choice Analysis of NTG Ratio: A nested logit model was used to conduct a discrete choice analysis to estimate NTG ratios. The unit of analysis for this model was the decision at the item level. Each item provided information on individual decisions made by the customer. The nested logit modeling system recognizes the correlations in unobserved factors over different options available to any given customer. A more comprehensive explanation is provided in Section VIII.

Billing Regression Analysis of NTG Ratio : For this method, a non-equivalent control group design was used to estimate was used to estimate net savings. This analysis compared billing histories associated with a sample of 450 participants and 450 non-participants. Modeling was conducted at the premise level. This method took participants who self-selected into the program and compared their electric consumption with that for non-participants. Because these two groups are, in practice, never equivalent, their differences were controlled for statistically. A NTG ratio was computed for this method by dividing the net savings estimate by the statistical estimate of gross saving. A more comprehensive explanation is provided in Section IX.

E. Data Flow Between Elements of the Impact Evaluation

Figure II-1 illustrates the data flow between the various elements of this study. The sampling process plus the various stages of the impact estimation procedure are shown running vertical down the left hand side of the figure. The various sources of data required to implement the sampling plan and the impact evaluation procedure are shown on the right hand side. The arrows indicate which data source is required by each estimation method. The figure also shows how certain of the estimation methods create data that are used in subsequent methods. In particular the figure shows that the enhanced engineering estimates of gross impact for the sample of participant sites where on-site surveys are conducted is used by the statistical analysis of gross impact. In addition, the statistical analysis of gross impact and the various methods for assessing net-to-gross ratios provide the information needed to evaluate net impact of the program by costing period.

Figure II-1. Data Flow for Impact Analysis



F. Compliance with M&E Protocols

The 1994 DSM programs are the first that must comply with the Protocols and Procedures for the Verification of Costs, Benefits, and Shareholder Earnings from Demand-Side Management (DSM) Programs (Protocols) as recently revised in January, 1995. Both with respect to gross and net impacts, the methodology and results in this evaluation are consistent with the current version of the Protocols and the revised version adopted in the 1995.

Gross Impacts

Regarding gross impacts, two issues merit attention: sample size and model type. First, the achieved sample size of 450 planned for in this evaluation is consistent with the requirement specified in Table 5 of the Protocols. Second, with respect to allowable regression-based models, the recently revised and approved Table C-4 now allows for the use of a load impact regression model (LIRM)) in estimating gross kWh impacts for HVAC equipment. This is consistent with the modeling approach used for this study.

Net Impacts

Regarding net impacts, the same two issues merit attention: sample size and model type. First, the achieved sample sizes of 450 for participants and 450 non-participants planned for in this evaluation are consistent with the requirement specified in Table 5 of the Protocols. Second, with respect to allowable regression-based models, the recently revised and approved Table C-4 allows the use of a LIRM approach as well as discrete choice models, both of which are used in this present study.

In some important ways, this evaluation goes beyond the Protocol requirements. For example, SAE models, considered superior by many in the evaluation community, while not required by the Protocols, were used to estimate gross impacts. Moreover, the quality of the engineering priors is far better than usually available from typical program tracking systems because the tracking system priors are re-estimated using on-site survey data and, where appropriate, superior engineering algorithms. This superior information is leveraged to reduce the bias stemming from measurement error and thus to provide better estimates of gross impacts. Finally, although the Protocols require that only one net-to-gross ratio be estimated, this evaluation provides estimates using three very different techniques. Such triangulation can be used to reduce the uncertainty surrounding any one estimate.

Reporting Requirements

The M&E reporting requirements contained in Tables 5, 6, 7, C-4, and C-12 were incorporated into this report.

III. Sample Selection and Disposition

Data were collected from a sample of participants, via telephone interviews and on-site surveys, and from a sample of non-participants, via telephone interviews. The data collected from these samples provided much of the information needed to satisfy this study's research objectives. This section describes how these samples were selected and the disposition of these samples.

A. Participant Sampling Unit and Sampling Frame

The participant sample frame was constructed from the ITEM table found in PG&E's program data base. This portion of the data base contains information on each item for which an incentive is paid by either the Retrofit Customized or Retrofit Express Programs. In general, an item is a distinct efficiency measure, e.g., setback thermostat, which affects a unique PG&E control number. However, the data base contains instances where items, having the same measure description, e.g., Thermostat: Setback Programmable, are associated with a single control number. The ITEM table is linked to the APP (or application) table via the variables Application Code and Program Year. The application table contains the Check Issue Date, which defines the year in which incentives were paid for each application, and thus for the items that are listed for each application in the ITEM table. An initial sample frame was built from the list of all items associated with applications paid during 1994. This initial frame contained data for 2,108 items.

Four adjustments were imposed on the initial frame which eliminated or forced the retention of selected items. In the first adjustment, 45 items were eliminated because they were associated with sensitive customers, identified by PG&E staff. In the second adjustment, items were eliminated which lacked usable pre-period consumption data. Control numbers in the initial frame were used to extract kWh consumption histories from PG&E's billing files. These data were examined to identify control numbers that had usable pre-period consumption data, i.e., of sufficient duration and quality to be used in the statistical analyses of gross or net savings. 352 items were associated with controls that did not have usable data. The third adjustment was to force the inclusion of the six Convert to VAV items and one Gas Absorption A/C item, found in the initial frame, regardless of whether they had usable pre-period consumption data. These seven items were associated with large kWh or Therm savings and were considered too important to leave out of the engineering analysis of gross savings. These three adjustments to the initial frame resulted in a net reduction of 377 items. The fourth and final adjustment was to exclude certain measures which accounted for a small fraction of the total program savings. The group of excluded items accounts for less than 5% of PG&E's estimate of kW or kWh or Therm savings, final participant frame consisting of 1,646 items. or of the estimated shareholder benefits. This final adjustment eliminated another 85 items, leaving a final participant frame consisting of 1,646 items.

B. Non-Participant Sampling Unit and Sample Frame

The non-participant sample frame was constructed from PG&E's billing files. Initially, the frame consisted of a large random sample of 20,000 control numbers, drawn from these files. This initial frame contained billing histories for each control number extending back to January 1, 1992. The control numbers in this initial frame were compared to a list of control numbers associated with HVAC measures paid in 1994 and matches were eliminated. In addition, the billing histories were inspected. Control numbers with billing histories that displayed anomalies difficult to correct or which did not extend for a sufficient period were eliminated. Finally, control numbers with annual 1994 kWh consumption less than

1500 were eliminated. The remaining 14,979 control numbers constituted the final frame for the non-participant sample.

C. Participant Study Domains

A study domain is a segment of the subject population for which separate impact estimates are to be derived. Study domains will be defined by the measure codes found in the program ITEM table. The first 3 columns in Table III-1, (Domains, Program and Measures) provide a definition of the study domains which will be used in preparing engineering estimates of gross savings (statistical estimates of net and gross savings will be prepared for the combined program as a whole).

In order to provide a complete picture of the population, the first domain shown in the table is the one which consists of the excluded measures. As can be seen in the far right columns, the excluded measures account for only a small portion of the HVAC measure savings for the combined Custom and Express programs. The greatest impact occurs for Therm savings where 3.26 percent of the total is excluded. Table III-2[1] shows the magnitude of the savings for each domain in kW, kWh, Therms and Shareholder Benefit dollars.

Shown below the Excluded domain are the High Savings and Other domains. The High Savings domain consists of a series of domains defined by specific HVAC measures. Treating each measure as a separate domain allow the size of the sample drawn to represent each measure to be controlled. Each of these measure specific domains accounts for more than 1.9 percent of total program energy savings, as measured in MMBtu (combination of kWh and Therm savings, converting both units to Btu). Collectively these measure specific High Savings domains account for more than 84 percent of total energy savings. PG&E desired as much information as possible for each of these measures in order to support future program planning activities.

The Other domain consists of the remaining measures associated with incentives in 1994. All of these remaining measures were grouped to create a single domain. Two measures which each account for more than 2 percent of total program savings were included in the Other domain because information on these measures is not sufficiently important for program planning to include them in the High Savings domain

A two-stage stratified random sampling procedure was used to select the participant sample. In the first stage of sampling, the sample for the telephone survey was selected. As shown in Table III-1, the completion target for this sample was 450 unique control numbers. For the telephone survey sample, all items in the frame with certainty (probability of selection equal to 1) were selected, except for those in three domains: (a) A/C: Central Air Cooled domain (738 items), (b) Reflective Window Film domain (257 items), and Other (424 items). For these domains, an optimally allocated, stratified sampling procedure was used. The optimization objective was to minimize the relative error of the estimate of total energy savings (MMBtu). Three strata were defined by using the Dalenius and Hodges method, as described Section 5A.7 in Sampling Techniques, 3rd Edition, by William G. Cochran. This technique yields strata boundaries at equal intervals of the cumulative sum of the square root of the MOS (MMBtu). A Neyman allocation, as described in Section 5.5 in Sampling Techniques, 3rd Edition, by William G. Cochran, was used to determine an optimum sampling fraction for each stratum. The population was over

[1] This table describes the frame after items associated with sensitive customers or unusable pre-period consumption data were eliminated, with the exception that Convert to VAV and Gas Absorption A/C items were retained even if they lacked usable pre-period consumption data.

sampled to allow for replacements. However, for the telephone survey, replacements could only be drawn from the three non-certainty domains.

In the second stage, a sub-sample of items to be included in the on-site surveys was selected. As shown in Table III-1, completion targets were established for two types of on-site surveys. The first type, (Column headed Cluster), are the items whose savings have been estimated using the cluster analysis technique (See Chapter V). This technique was only used for High Savings domain items. The second type, (Column headed Matched Pair), are the items whose saving were estimated using the matched-pair analysis technique. This technique was used for Retrofit Express program items in the High Savings domains and in the Other domain. As shown in Table III-1, the on-site survey sample (combination of cluster analysis and matched-pair sites) is a small fraction of the population in most domains. Therefore, to maximize the precision of the estimates for each of these domains, an optimum allocation stratified sampling procedure was used when feasible to select the on-site survey sub-sample. The stratification strategy for each of the High Savings domains on-site surveys is shown in Table III-3. One, two or three strata were used, depending on the size of the population in each domain. Also shown in Table III-3 is the stratification strategy for the Other domain. A portion of the matched-pair sample was allocated to this domain.

As with the first stage of sampling (telephone survey) it was necessary to over sample in the second stage (on-site) surveys to allow for replacements. Candidate sites from the telephone survey were used as they were recruited to fill the on-site survey quota.

The allocation of the telephone survey between the High Savings and the Other domains is based on their proportion of total energy consumption. Among the High Savings domains, the telephone survey is allocated to achieve certainty samples in all but two of the domains, which leaves relatively large, but equal samples of the two remaining non-certainty domains. Allocation of the on-site survey sub samples is based on qualitative considerations. The allocations balance a need to represent all domains against the requirement of accurately representing the program as a whole, which requires allocation of more cases to those measures which account for a larger proportion of total program savings. None of the matched-pair sample was allocated to Custom program measures, because the program estimates of savings are customer specific and are probably of about the same accuracy as the estimates that were produced by the matched-pair technique.

Table III-1: Participant Sample Frame, Quotas, and Percent Savings

Table III-2: Program Data Base Savings by Participant Study Domain

Table III-3: Telephone and On-Site Strata Quotas

			Unique Control #'s				
		Number			On-Site Quota		
Domain	Strata	of Items in Frame	In Frame	Telephone Quota	Total	Cluster	Matched Pair
A/C: Central Air Cooled	1	408	326	14	1	0	1
A/C: Central Air Cooled	2	215	191	11	1	1	0
A/C: Central Air Cooled	3	115	100	56	6	2	4
Adjustable Speed Drive: HVAC Fan, 50 HP Max	1	25	23	22	3	1	2
Adjustable Speed Drive: HVAC Fan, 50 HP Max	2	15	15	15	9	2	7
Convert to VAV	1	6	6	6	3	3	0
Cooling Tower	1	26	26	26	12	3	9
Cooling Tower	2	10	10	10	10	4	6
Evaporative Cooler	1	18	18	18	3	1	2
Evaporative Cooler	2	5	5	5	5	2	3
Gas Absorption A/C	1	1	1	1	1	1	0
HVAC Adjustable Speed Drive	1	20	19	19	3	3	0
HVAC Adjustable Speed Drive	2	8	8	8	6	6	0
HVAC Resize Motor/Compressor	1	3	3	3	2	2	0
Install HVAC EMS	1	33	32	32	4	4	0
Install HVAC EMS	2	11	11	11	11	11	0
Other	1	259	196	9	1	0	1
Other	2	119	110	15	1	0	1
Other	3	46	46	46	12	0	12
Reflective Window Film	1	156	154	23	1	0	1
Reflective Window Film	2	76	72	37	1	1	0
Reflective Window Film	3	25	25	25	10	2	8
Water Chiller Air Cooled	1	18	11	11	10	3	7
Water Chiller Water Cooled	1	21	21	21	16	4	12
Water Chiller Water Cooled	2	7	7	7	7	4	3

D. Non-Participant Sampling Procedure

A stratified sampling procedure was used to draw a sample of control numbers from the non-participant sample frame. Five strata were defined by using the Dalenius and Hodges method. This technique yielded strata boundaries at equal intervals of the cumulative sum of the square root of the MOS (annual kWh). In allocating the sample among these strata, the objective was to produce a non-participant sample that had approximately the same distribution of annual kWh consumption as the participant population. The fraction of the participant population that fell within the boundaries of each strata was computed. The same fraction was used in determining the number of non-participants to draw from each strata. 1800 control numbers were selected to allow for sufficient replacements. 193 of these control numbers were eliminated for the following reasons: (a) overlap with PG&E's BCUS survey, (b) overlap with the participant and non-participant sample drawn by PG&E to evaluate lighting retrofit projects, (c) invalid PG&E division codes, and (d) customers identified as being sensitive by division customer representatives. Further discussion of these reasons and the analyses performed to examine the impact of these eliminations is provided in Appendix D. These analyses, based on information available prior to fielding the telephone survey, revealed that the representativeness of the sample was not compromised by eliminating these 193 control numbers from the non-participant sample.

E. Telephone Survey Sample Disposition

The sample dispositions of the telephone surveys for the participants and the non-participants are described below.

Participant Survey

Telephone surveys were completed with 450 participant sites with a response rate of 55%. The disposition of the sample is presented in Table III-4. Highlights of the results are:

- (189/818) did not complete an interview because, while still active in the sample, they had not as yet been contacted when interviewing quotas[2] were reached.
- (65/818) refused
- (91/818) did not answer after 7 attempts.

Non-Participant Survey

Telephone surveys were completed with 450 non-participant sites with a response rate of 64%. The disposition of the sample is presented in Table III-5. Highlights of the results are:

- (154/705) did not complete an interview because, while still active in the sample, they had not as yet been contacted when interviewing quotas were reached.
- (44/705) refused
- (50/705) did not answer after 7 attempts.

[2] Active is defined as not having been contacted as yet and not having as yet been called 7 times.

Table III-4. Final Participant HVAC Sample Disposition

Disposition Categories	Control Numbers
Starting Sample	886
Out of Sample	
Names pulled per PG&E	28
No listing/disconnected/ no customer information provided/non-replacement	40
Adjusted Sample	818
No Answer After 7 Attempts	91
Partial Completes	23
Refusals	65
Still Active When Quotas Reached	189
Completed Survey	450
Response Rate	55%

Table III-5 Final Non-Participant HVAC Sample Disposition

	Disposition Categories	Control Numbers	
	Starting Sample	1154	
	Out of Sample		
	Names pulled per PG&E	117	
	No listing/disconnected	83	
	No cooling system	135	
	Received 1994 rebate	43	
	Language barrier	18	
	Business moved	25	
	Not a business	28	
	Adjusted Sample	705	
	No Answer After 7 Attempts	50	
	Partial Completes	7	
	Refusals	44	
	Still Active When Quotas Reached	154	
	Completed Survey	450	
	Response Rate	64%	

F. Participant On-Site Survey Sample Disposition

As part of the participant telephone survey, customers were asked whether they would allow members of our study team to conduct an on-site survey. As positive responses were received, they were forwarded to members of the team responsible for scheduling the on-site surveys. The objective of the scheduling process was to satisfy as many of the domain quotas (see Table III-3) as possible. Customers associated with 210 control numbers were asked if they would allow an on-site survey. Negative responses were received, either during the telephone survey or a subsequent scheduling call, from customers associated with 56 of these control numbers. In addition, 14 control numbers were rejected because of problems with the data available from the MDSS data base or associated paper files. Most of these problems involved misclassified measures or savings estimates that spanned multiple end uses, such as HVAC and lighting. On-site surveys were scheduled and successfully completed for 140 control numbers.

Table III-6 shows the on-site survey completions at the item level for both cluster and match-pair sites, by domain and strata[3]. Cluster site surveys were completed for 74 items associated with 60 unique control numbers. Matched-pair site surveys were completed for 99 items associated with 80 unique control numbers.

G. Sample-Based Estimates of Program Savings

Tables III-7, III-8, and III-9 show telephone survey sample performance for electric consumption, electric demand, and gas consumption savings respectively. For electric consumption savings, the weighted sample total of 63.97 GWh differs by only 0.1% from the program data base total of 64.10 GWh. Demand savings show a larger discrepancy: 14.04 MW from the weighted sample versus 14.71 MW in the data base, a difference of 4.6%. Gas savings in the survey total 525 kTherms, and in the data base 554 kTherms, a difference of 5%.

Each table also lists the relative errors at a 90% confidence level. The relative error states, as a percentage, the upper and lower limits within which one could be 90% confident the true estimate of savings lies. Small sample counts relative to the population count, as well as large variations in individual estimates, can all increase the relative error. As a result, relative errors are very high for many of the individual measures, but are lower at total level and for the high savings domain. For the telephone survey weighted sample total, the relative error for the total electric consumption savings estimate is 6.9%. For total electric demand and gas consumption savings, the relative errors are 10% and 19%, respectively.

Tables III-10, III-11, and III-12 show on-site survey sample performance for electric consumption, electric demand, and gas consumption savings respectively. For electric consumption savings, the weighted sample total of 65.01 GWh differs by 1.7% from the program data base total of 64.01 GWh. Demand savings show a larger discrepancy: 15.34 MW from the weighted sample versus 14.71 MW in the data base, a difference of 4.3%. Gas savings in the survey total 545 kTherms, and in the data base 554 kTherms, a difference of 1.6%. Relative errors for weighted sample estimates of electric consumption, electric demand, and gas consumption savings are 19.3%, 15.6%, and 44.0%, respectively.

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[3] Strata 9, under Install HVAC EMS, is a post hoc strata and thus does not appear in the strata quotas shown in Table III-2. This strata was created to accommodate one item with extremely large savings that fell in stratum 2 in the sample design. Isolating this item in a separate certainty stratum (case weight = 1), dramatically improves the population estimates derived from the sample of completed items.

Table III-6 On-Site Survey Completions by Domain and Strata

Table III-7 Telephone Survey Sample Performance (Electric Usage Savings)

Domain/Measure	Pop. Total	Data Base Total Savings (GWh)	Telephone Survey: No. of Items Chosen	% of DB counts Sampled	Weighted Sample DB Total (GWh)	% diff & Sample Savings	RE @ 90% CL
High Savings	**1,491**	**55.97**	**522**	**35.0**	**56.28**	**0.6**	**7.6**
A/C (Central Air-cooled)	912	1.80	227	24.9	1.68	-6.3	6.2
ASD (HVAC Fan < 50 hp)	52	3.20	28	53.8	2.67	-16.5	9.7
Convert to VAV	6	2.02	3	50.0	3.23	60.5	84.2
Cooling Tower	38	4.63	27	71.1	4.59	-0.8	22.7
Evaporative Cooler	26	2.23	14	53.8	2.59	16.3	32.1
Gas Absorption A/C	1	0.00	1	100.0	0.00	--	--
Adjust. Speed Drive	30	6.21	15	50.0	7.01	12.9	27.8
Resize Motor/Compr.	3	6.29	3	100.0	6.29	0.0	0.0
Install HVAC Energy Mgmt. Sys.	58	18.35	36	62.1	18.57	1.2	8.4
Reflective Window Film	313	4.59	134	42.8	2.41	-47.4	15.1
Water Chiller (Air Cooled)	22	1.74	14	63.6	2.46	41.5	45.4
Water Chiller (Water-Cooled)	30	4.92	20	66.7	4.76	-3.1	26.3
Other	**512**	**8.04**	**147**	**28.7**	**7.69**	**-4.3**	**11.3**
Total	**2003**	**64.01**	**669**	**33.4**	**63.97**	**-0.1**	**6.9**

(RE=relative error, CL=confidence level)

Table III-8 Telephone Survey Sample Performance (Electric Demand Savings)

Domain/Measure	Pop. Total	Data Base Total Savings (MW)	Telephone Survey: No. of Items Chosen	% of DB counts Sampled	Weighted Sample Total (MW)	% diff DB & Sample Savings	RE @ 90% CL
High Savings	**1,491**	**13.88**	**522**	**35.0**	**13.65**	**-1.7**	**10.3**
A/C (Central Air-cooled)	912	1.59	227	24.9	1.53	-4.2	8.3
ASD (HVAC Fan < 50 hp)	52	0.00	28	53.8	0.00	--	0.0
Convert to VAV	6	0.30	3	50.0	0.61	100.0	0.0
Cooling Tower	38	3.89	27	71.1	3.86	-0.9	22.1
Evaporative Cooler	26	0.83	14	53.8	0.95	14.8	31.9
Gas Absorption A/C	1	0.00	1	100.0	0.00	--	--
Adjust. Speed Drive	30	0.00	15	50.0	0.00	-100.0	0.0
Resize Motor/Compr.	3	0.98	3	100.0	0.98	0.0	0.0
Install HVAC Energy Mgmt. S	58	0.39	36	62.1	0.53	35.8	0.0
Reflective Window Film	313	1.63	134	42.8	0.84	-48.7	15.3
Water Chiller (Air Cooled)	22	1.04	14	63.6	1.47	41.1	48.0
Water Chiller (Water-Cooled)	30	3.21	20	66.7	2.88	-10.3	27.6
Other	**512**	**0.83**	**147**	**28.7**	0.39	**-52.8**	**27.2**
Total	**2003**	**14.71**	**669**	**33.4**	14.04	**-4.6**	**10.0**

(RE= relative error, CL= confidence level)

Table III-9 Telephone Survey Sample Performance (Gas Usage Savings)

Domain/Measure	Pop. Total	Data Base Total Savings (kTherms)	Telephone Survey: No. of Items Chosen	% of DB counts Sampled	Weighted Sample DB Total (kTherms)	% diff DB & Sample Savings	RE @ 90% CL
High Savings	**1,491**	**410**	**522**	**35.0**	**517**	**26.1**	**19.3**
A/C (Central Air-cooled)	912	0	227	24.9	0	--	--
ASD (HVAC Fan < 50 hp)	52	0	28	53.8	0	--	--
Convert to VAV	6	22	3	50.0	44	100	78.7
Cooling Tower	38	0	27	71.1	0	--	--
Evaporative Cooler	26	0	14	53.8	0	--	--
Gas Absorption A/C	1	134	1	100.0	134	--	0
Adjust. Speed Drive	30	8	15	50.0	12	50	0
Resize Motor/Compr.	3	0	3	100.0	0	--	--
Install HVAC Energy Mgmt. !	58	246	36	62.1	327	33	28.6
Reflective Window Film	313	0	134	42.8	0	--	--
Water Chiller (Air Cooled)	22	0	14	63.6	0	--	--
Water Chiller (Water-Cooled)	30	0	20	66.7	0	--	--
Other	**512**	**144**	**147**	**28.7**	**8**	**-94**	**0.0**
Total	**2003**	**554**	**669**	**33.4**	**525**	**-5.1**	**19.0**

(RE=relative error, CL=confidence level)

Table III-10 On-site Survey Sample Performance (Electric Usage Savings)

Domain/Measure	Pop. Total	Data Base Total Savings (GWh)	Onsite Survey No. of Items Chosen	% of DB counts Sampled	Weighted Sample Total (GWh)	% diff DB & Sample Savings	RE @ 90% CL
High Savings	**1,491**	**55.97**	**156**	**10.5**	**58.19**	**4.0**	**20.1**
A/C (Central Air-cooled)	912	1.80	32	3.5	1.58	-12.2	23.9
ASD (HVAC Fan < 50 hp)	52	3.20	15	28.8	2.66	-16.9	39.1
Convert to VAV	6	2.02	3	50.0	3.23	60.5	71.5
Cooling Tower	38	4.63	25	65.8	4.56	-1.5	33.4
Evaporative Cooler	26	2.23	8	30.8	2.65	19.1	54.8
Gas Absorption A/C	1	0.00	1	100.0	0.00	--	--
Adjust. Speed Drive	30	6.21	6	20.0	4.99	-19.6	49.3
Resize Motor/Compr.	3	6.29	2	66.7	9.35	48.6	84.1
Install HVAC Energy Mgmt. S	58	18.35	14	24.1	17.88	-2.6	16.8
Reflective Window Film	313	4.59	28	8.9	3.00	-34.6	40.2
Water Chiller (Air Cooled)	22	1.74	5	22.7	3.70	112.4	42.3
Water Chiller (Water-Cooled)	30	4.92	17	56.7	4.59	-6.7	28.8
Other	**512**	**8.04**	**17**	**3.3**	**6.91**	**-14.1**	**55.3**
Total	**2003**	**64.01**	**173**	**8.6**	**65.10**	**1.7**	**19.3**

(RE=relative error, CL=confidence level)

Table III-11 On-site Survey Sample Performance (Electric Demand Savings)

Domain/Measure	Pop. Total	Data Base Total Savings (MW)	No. of Items Chosen	Onsite Survey % of DB counts Sampled	Weighted Sample Total (MW)	% diff DB & Sample Savings	RE @ 90% CL
High Savings	**1,491**	**13.88**	**156**	**10.5**	**15.21**	**9.6**	**15.9**
A/C (Central Air-cooled)	912	1.59	32	3.5	1.56	-2.0	32.7
ASD (HVAC Fan < 50 hp)	52	0.00	15	28.8	0.00	--	36.2
Convert to VAV	6	0.30	3	50.0	0.61	100.0	90.9
Cooling Tower	38	3.89	25	65.8	3.75	-3.6	35.0
Evaporative Cooler	26	0.83	8	30.8	0.98	18.0	64.1
Gas Absorption A/C	1	0.00	1	100.0	0.00	--	--
Adjust. Speed Drive	30	0.00	6	20.0	0.00	-100.0	46.7
Resize Motor/Compr.	3	0.98	2	66.7	1.47	50.0	45.2
Install HVAC Energy Mgmt. S	58	0.39	14	24.1	0.56	42.6	30.5
Reflective Window Film	313	1.63	28	8.9	1.05	-35.5	36.6
Water Chiller (Air Cooled)	22	1.04	5	22.7	2.34	124.2	79.1
Water Chiller (Water-Cooled)	30	3.21	17	56.7	2.89	-10.1	26.2
Other	**512**	**0.83**	**17**	**3.3**	**0.13**	**-84.8**	**79.4**
Total	**2003**	**14.71**	**173**	**8.6**	**15.34**	**4.3**	**15.6**

(RE= relative error, CL= confidence level)

Table III-12 On-site Survey Sample Performance (Gas Usage Savings)

Domain/Measure	Pop. Total	Data Base Total Savings (kTherms)	Onsite Survey No. of Items Chosen	% of DB counts Sampled	Weighted Sample Total (kTherms)	% diff DB & Sample Savings	RE @ 90% CL
High Savings	**1,491**	**410**	**156**	**10.5**	**545**	**32.9**	**54.0**
A/C (Central Air-cooled)	912	0	32	3.5	0	--	--
ASD (HVAC Fan < 50 hp)	52	0	15	28.8	0	--	--
Convert to VAV	6	22	3	50.0	44	100.0	102.2
Cooling Tower	38	0	25	65.8	0	--	--
Evaporative Cooler	26	0	8	30.8	0	--	--
Gas Absorption A/C	1	134	1	100.0	134	0.0	0.0
Adjust. Speed Drive	30	8	6	20.0	0	-100.0	-70.0
Resize Motor/Compr.	3	0	2	66.7	0	--	--
Install HVAC Energy Mgmt. S	58	246	14	24.1	367	49.2	62.3
Reflective Window Film	313	0	28	8.9	0	--	--
Water Chiller (Air Cooled)	22	0	5	22.7	0	--	--
Water Chiller (Water-Cooled)	30	0	17	56.7	0	--	--
Other	**512**	**144**	**17**	**3.3**	**0**	**-100.0**	**63.3**
Total	**2003**	**554**	**173**	**8.6**	**545**	**-1.6**	**44.0**

(RE=relative error, CL=confidence level)

IV. Data Collection and Application

Data were collected from a variety of sources to satisfy the information requirements of the four components of this study: (a) participant and non-participant sample selection, (b) engineering analysis of gross impacts, (c) statistical analysis of gross impacts, and (d) statistical analysis of net impacts. The sources of these data were as follows:

1. PG&E's Program Data Base
2. PG&E's Program Job Files
3. PG&E Billing Data
4. Weather Data
5. Participant and Non-Participant Telephone Surveys
6. On-site Surveys

This section describes, for each of the sources, how the required data were obtained and applied to the evaluation.

A. PG&E's Program Data Base

PG&E provided copies of the data base files that contained electronic information on the paid applications processed by the Retrofit Programs between 1990 and 1995. These files included the relevant variables from the item and application tables of the program data base. The application table contained the dates rebates were paid, and was used to define the paid 1994 HVAC items that were the subject of this evaluation. Historical information on rebates paid during other years was used in the statistical analyses of savings. Information about the the lighting rebates paid during 1994 was used in the lighting/HVAC interaction analysis.

As described in Section II, the data base files were used to construct the participant sample frame. They contained the following information for each item:

1. Application number
2. Program year
3. PG&E sales engineer
4. PG&E division
5. Name of person/organization to whom rebate was paid
6. Address of person/organization to whom rebate was paid
7. Code indicating the program which processed the application
8. Estimate of kWh, kW, and therm savings developed by PG&E's program staff

The application number and program year were used to generate item numbers. The application number, program year, and item number variables were designated key variables. A combination of these three variables specifies a unique item. The participant sample was drawn from this frame and a list of selected information for each item was distributed to PG&E's division staff and major account representatives, in order to identify sensitive customers. The data also provided a starting point for reviewing each job included in the participant sample.

B. PG&E's Program Files

A list of sampled participants was submitted to PG&E. PG&E provided a copy of the files maintained by the program for the participants. These files normally contained copies of the rebate applications as well as additional documentation, such as selected design drawings and manufacturer equipment specifications.

From these files, the following information necessary to support the engineering analysis of gross savings was extracted:

- Program application
- Post field documentation
- Measure description and location
- Building characteristics (type, floor area)
- Date and amount of payment (PG&E rebate check)

Contact names, addresses and phone numbers were not provided in the program data base, so this information was taken from the program files.

C. PG&E Billing Data

Once the on-site surveys were completed, a comprehensive list of the electric and gas meters that were found at the sixty cluster analysis sites was compiled. This list included the control numbers associated with each site in the program data base. PG&E reconciled this list with its master data base to ensure that the identified meter numbers were indeed valid. Some of the meter numbers found during the on-site were improperly transcribed, measured only reactive power or demand, or did not serve measure-affected areas. Once all of these discrepancies were identified and corrected, PG&E extracted monthly electric and gas consumption and electric demand billing records for all of the cluster sites. Billing data were also obtained for all remaining telephone survey participants and for 450 non-participants.

From the list of cluster site control numbers, PG&E also searched for sites fitted with half-hourly demand metering. Sites with such data were to be calibrated on an hourly level. Half-hourly demand data were not found, however, for any of the cluster sites.

D. Weather Data

Weather data were obtained from the National Oceanic and Atmospheric Administration (NOAA) and PG&E. NOAA maintains seven long-term climatic measurement station throughout PG&E's service territory. Typical Meteorological Year (TMY) weather data from these sites were input into the DOE 2.1E simulations to estimate gross savings over long-term conditions. PG&E maintains 33 stations that record hourly temperature and relative humidity. PG&E provided information for matching these weather stations with each of the 60 cluster sites based on the PG&E local office associated with the site. Once these matches were made, the actual temperatures and relative humidities that PG&E recorded during the study period were substituted into the NOAA TMY weather files. These modified weather files provided actual weather conditions, which combines with the actual billing data, allowed the DOE 2.1E simulations to be calibrated. The actual temperatures PG&E supplied were also used to calculate weekly heating and cooling degree-day totals. These totals were fed to the statistical analysis models.

E. Participant and Non-Participant Telephone Surveys

Telephone surveys were conducted with 450 participants and 450 non-participants to collect data needed for the statistical analysis of gross and net savings. These questionnaires collected a variety of information about equipment stock, the efficiency of equipment added or replaced during the study period, and any other major changes during the same period that might affect energy consumption, such as changes in square footage or major renovations. Participants were also asked a battery of questions concerning the effect of the PG&E rebate on their purchase(s) of efficient equipment. Included in this battery were questions regarding when they became aware of the PG&E program and whether they would have purchased the same equipment without the PG&E rebate. These questions, along with several others, were input into statistical models for estimating a net-to-gross ratio. Participants were also asked to participate in an on-site survey of the location where the equipment was installed.

For both participants and non-participants, company names, service and mailing addresses, and, in some cases, telephone numbers were obtained from the PG&E commercial customer data base. Missing telephone numbers were obtained from directory assistance. When necessary, telephone surveyors made multiple phone calls to contact the person most knowledgeable about energy systems at a particular location. For non-participants, surveys were first attempted with customers for whom complete billing and service addresses were available. One questionnaire was completed for each participant and non-participant premise. The participant and non-participant versions of these surveys are attached in Appendix A.

It was, of course, possible that for both groups, more than one premise could be associated with a given corporate entity and could turn up in the sample. Therefore, after the two samples were drawn, sites were grouped by corporate entity. This relieved customers of responding to several telephone calls, one for each of the sites. Thus, single site cases and multiple sites cases were handled differently.

For single sites, the initial contact person was asked questions regarding their participation in the program and the characteristics of the specific building in which the efficient was installed through the program. In most cases, this person was able to provide information about the building, while in a few other cases the surveyor was referred to someone else who was better prepared to answer our questions. For participants, the last set of questions (questions 62 through 68 in the questionnaire in Appendix A) sought to determine whether the respondent had the authority to grant permission for an on-site survey and, if so, would they grant permission for such a survey. If they were not the appropriate person, the surveyor was referred to the person who had such authority.

In the case of participant multiple sites, for which the same person with the same corporate affiliation was mentioned in the program data base as the contact person for multiple records, this one person was called once regarding all the sites. In the case of non-participant multiple sites in which the same corporate entity was associated with more than one control number, the surveyor attempted first to contact the appropriate corporate-level person. In the case of both participant and non-participant multiple sites, the person contacted was asked whether they could answer questions regarding each of the specific sites. If they could not, the surveyor was referred to the individual at each of the sites who could answer these questions.

If this person could answer questions regarding each of the specific sites, the surveyor asked them to provide information on no more than three buildings. If more than three buildings were involved, the questionnaire was completed for three randomly-selected buildings.

As in the case of single participant sites, the last set of questions determined whether the respondent had the authority to grant permission for an on-site survey and, if so, whether they would they grant such permission. If they were not the appropriate person, the surveyor was referred to the person who had such authority.

For the participants, a pretest was conducted with 21 randomly selected customers prior to survey implementation to learn of any possible changes in survey design or question wording. The pretest was conducted from May 18 through May 22, 1995. The pretest resulted in only minor revisions for a few questions. Survey data were collected by telephone from June 1 through July 19, 1995. A minimum of 7 attempts were made to contact customers in the domains with high estimated savings. Where these attempts still failed, telephone interviewers obtained a fax number for 22 customers and PG&E faxed letters to these customers explaining the study and requesting their cooperation. This effort by PG&E resulted in an additional 10 surveys being completed. Telephone surveys were completed with 450 participant sites with a response rate of 55%. A discussion of the disposition of the sample was presented earlier in Section III.

For the non-participants, pretest was conducted with 20 randomly selected customers prior to survey implementation to learn of any possible changes in survey design or question wording. The pretest was conducted from August 10 through August 14, 1995. The results of the pretest resulted in only minor revisions for a few questions. Survey data were collected by telephone from August 14 through September 18, 1995. Telephone surveys were completed with 450 non-participant sites with a response rate of 64%. A discussion of the disposition of the sample was presented earlier in Section III.

As both types of surveys were completed, they were coded by a data editor. The editor checked survey skip patterns and coded open-ended responses into categories of interest. Next, the surveys were entered directly into the Statistical Package for the Social Sciences (SPSS) using the data entry module. Finally, a research associate conducted data cleaning procedures. These procedures checked for out-of-range codes, improper skip patterns, and other inconsistencies.

F. On-Site Surveys

On-site data collection was required to support the engineering analysis of gross savings. Data collected in this task was also used to evaluate the measurement error associated with the telephone survey data. Two types of on-site survey instuments were developed, a detailed survey for cluster sites and a simplified survey for matched-pair sites. Each survey was first field-tested on several sites, and feedback from the pre-tests was incorporated into the final survey designs. The final versions of the on-site survey instruments are included in Appendix A. Field staff attended a training session to learn proper methods for completing the surveys, and also received a data collection handbook to provide additional guidance in the field.

For both the cluster and matched-pair sites, the overall procedure was similar. The field staff first contacted the building owner and scheduled the site visit. During the visit the field staff completed the appropriate survey by gathering information on the key determinants of electrical and gas energy use, as well as on the pre-condition and as-built characteristics of the HVAC measures. Some of the key parameters included:

1. The capacity and efficiency (based on the make and model) and quantity of the equipment that comprised the measure.
2. Type of HVAC system, operating schedule, controls (including thermostat settings) and other performance parameters.
3. Operating schedule for internal loads in the conditioned spaces served by the affected HVAC system.
4. Power density of internal loads in those spaces.
5. Envelope characteristics (e.g., conditioned floor area, number of floors, percent glazing, glazing type).

Any other information particularly important for the DOE 2.1E simulations was also recorded. A portion of the telephone survey instrument for each site was also completed, so that direct observation of certain key variables could be compared to responses received in the telephone survey. Observations for the following parameters were made to verify the telephone survey responses:

1. Enclosed floor area and fraction of floor area heated and cooled by electricity
2. Space heating and cooling fuel types
3. Main business activity
4. Electric metering configuration
5. Year built
6. Glass fraction of gross wall area
7. Employee working hours
8. Heating and cooling system operation during non-business hours.

For cluster sites, field staff also took one-time measurements of lighting and miscellaneous equipment loads. The data collected during the on-site survey were entered into the project data base or were neatly written on paper forms so that the work at each site was fully documented. All data collected during the cluster and matched-pair analysis on-site surveys were documented on the series of forms provided in Appendix A.

After the clustering analysis was completed and the eight calibration and test sites were selected, these sites were subjected to a second on-site survey. This survey collected more detailed information on envelope characteristics and HVAC system configuration to support a detailed DOE 2.1E simulation. At the five calibration sites, a series of short-term hourly end-use measurements were taken during the summer of 1995. Synergistics C-180 hourly data recorders were installed at each site per the requirements of the measurement plan that was developed during the on-site survey. The specific measurement configuration employed at each site to record the required data was documented in a measurement plan detailing sensor configuration, time intervals, channel assignments, and zoning information After the data was verified to be complete and accurate, the measurement system was removed.

V. Methodology for Engineering Analysis of Gross Impact

Engineering estimates of gross savings were prepared for all participant sites where on-site surveys were completed. Savings were computed for sampled HVAC measures for which a rebate was paid in 1994. This section describes the methods used to prepare these engineering estimates.

A. Summary of Methods and Input Data

The data collected during the on-site surveys were used to develop engineering estimates of gross savings (kWh, kW and therms), by costing period, for the sampled HVAC measures. Two classes of analysis were performed. The most rigorous class of analysis was performed on the cluster analysis sites, using a DOE-2.1E simulation model to estimate savings for these sites. DOE 2.1E simulations were also used to apply a less rigorous level of analysis to the matched-pair sites. The two classes of analysis are summarized below.

Cluster Analysis (Class 1)

The first class of engineering analysis involved the development of a simulation model with DOE-2.1E for each cluster site and the use of the model to estimate base case and efficient case consumption for each site. Efficient case consumption for each site was calibrated to utility billing records for a calibration period of up to one year. For the calibration sites, the results of the short term measurements were integrated into the calibration process. The gross impact of the program measures sampled at each site was defined as the difference between base and efficient case consumption under typical weather conditions.

Matched-Pair Analysis (Class 2)

The second class of engineering analysis involved the development of a simulation model (DOE-2.1E or equivalent hand calculation) for each matched-pair site and the use of the model to estimate base and efficient case consumption for each site. The matched-pair analysis provided a less rigorous assessment of savings than was performed for cluster analysis sites. In this analysis, typical efficient post-period use (gas and electric) was estimated for each matched-pair site by modifying simulation inputs prepared for its paired cluster analysis site. These modifications reflected the as-built condition observed at the matched-pair site for certain key variables. The gross impact of the program measures sampled at each site was defined as the difference between base and efficient case consumption under typical weather conditions.

Flow diagrams of the cluster and matched-pair analysis procedures are presented in Figures V-1 and V-2, respectively.

Figure V-1: Flow Diagram of Cluster Analysis Procedures

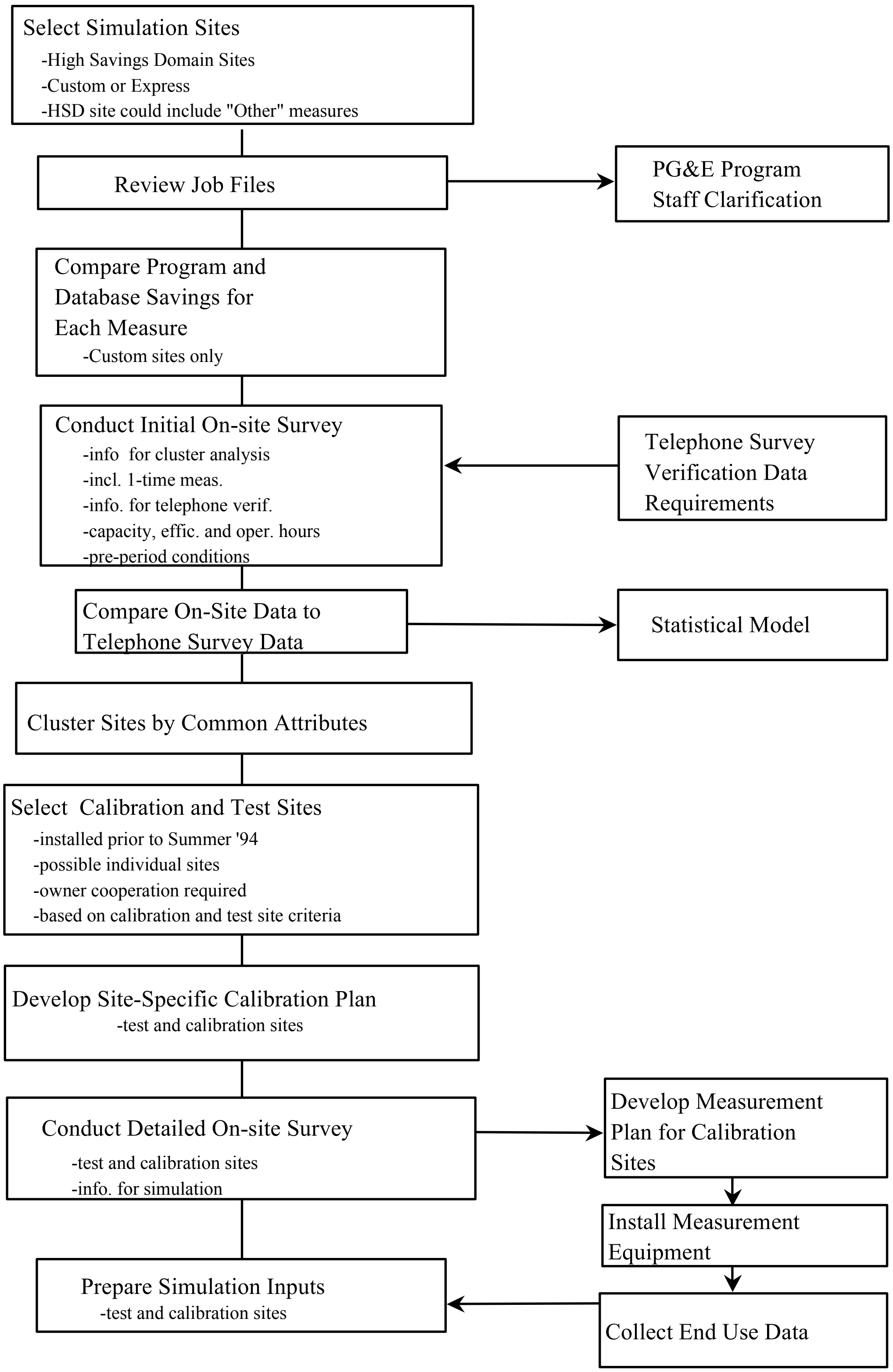


Figure V-1: Flow Diagram of Cluster Analysis Procedures (continued)

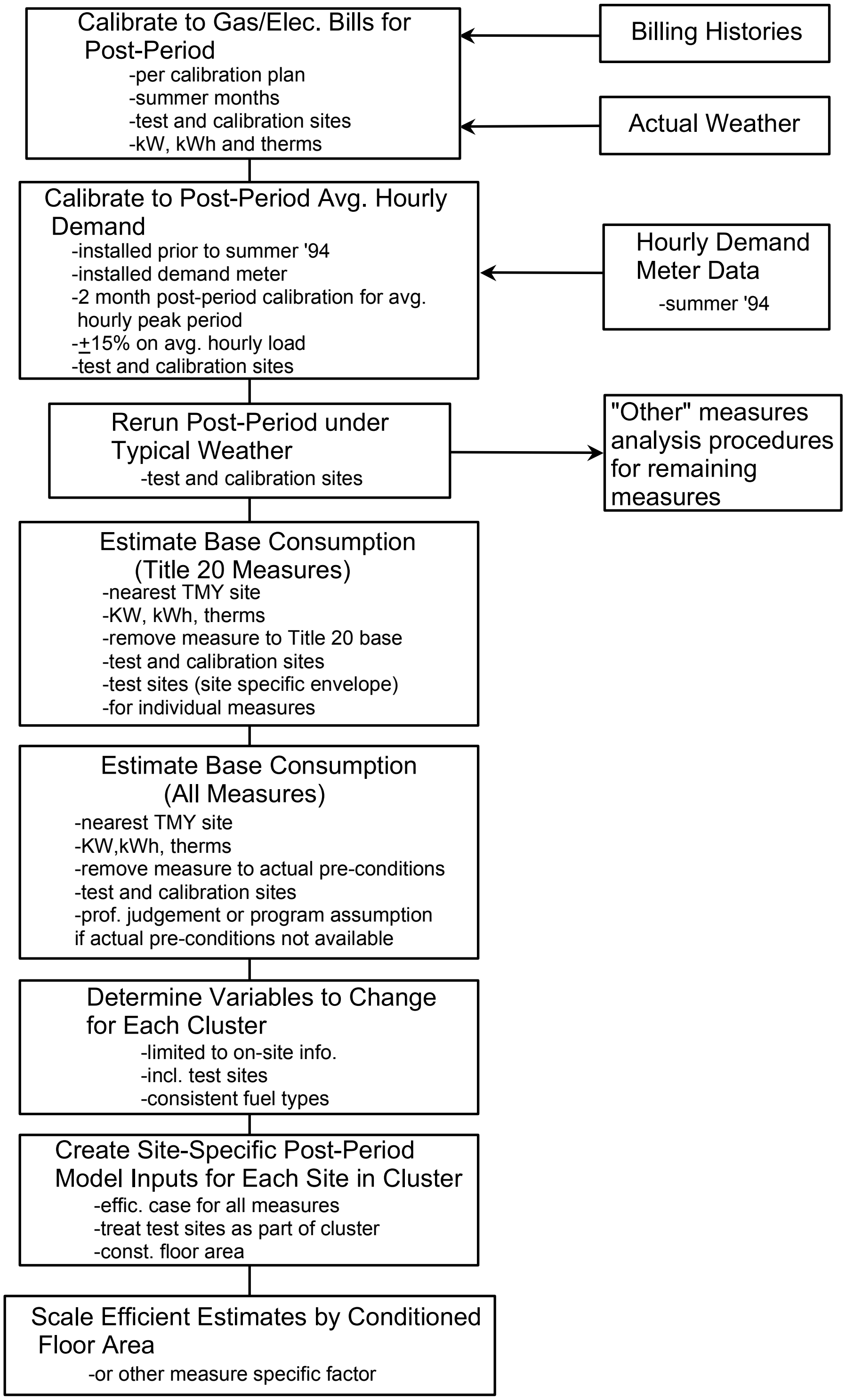


Figure V-1: Flow Diagram of Cluster Analysis Procedures (continued)

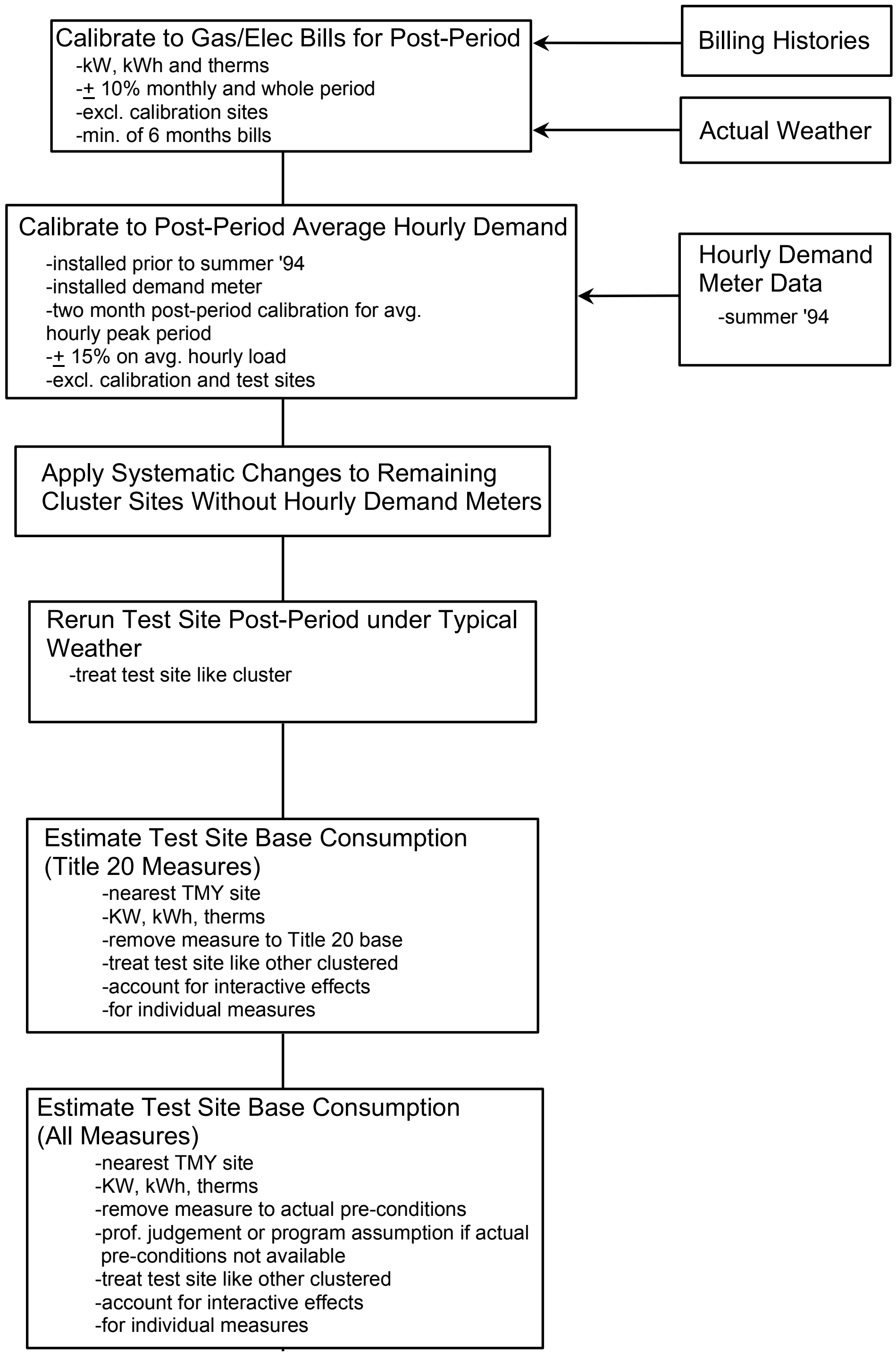


Figure V-1: Flow Diagram of Cluster Analysis Procedures (continued)

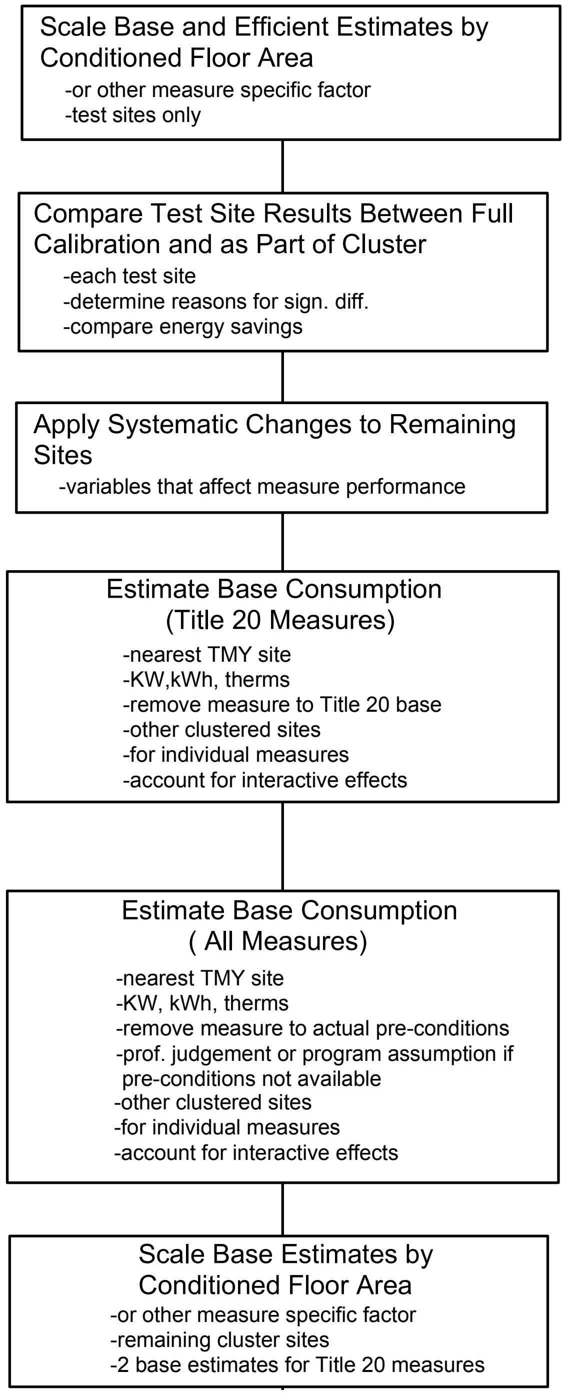


Figure V-1: Flow Diagram of Cluster Analysis Procedures (continued)

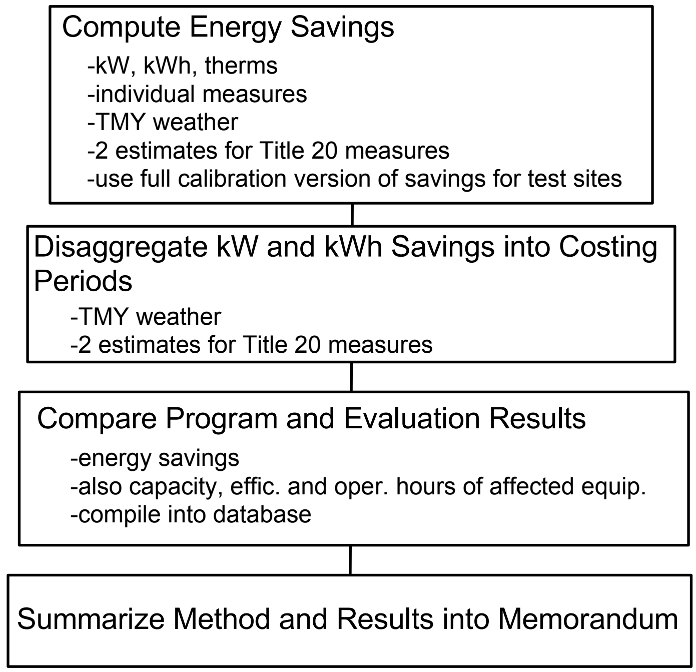


Figure V-2: Flow Diagram of Matched-Pair Analysis Procedures

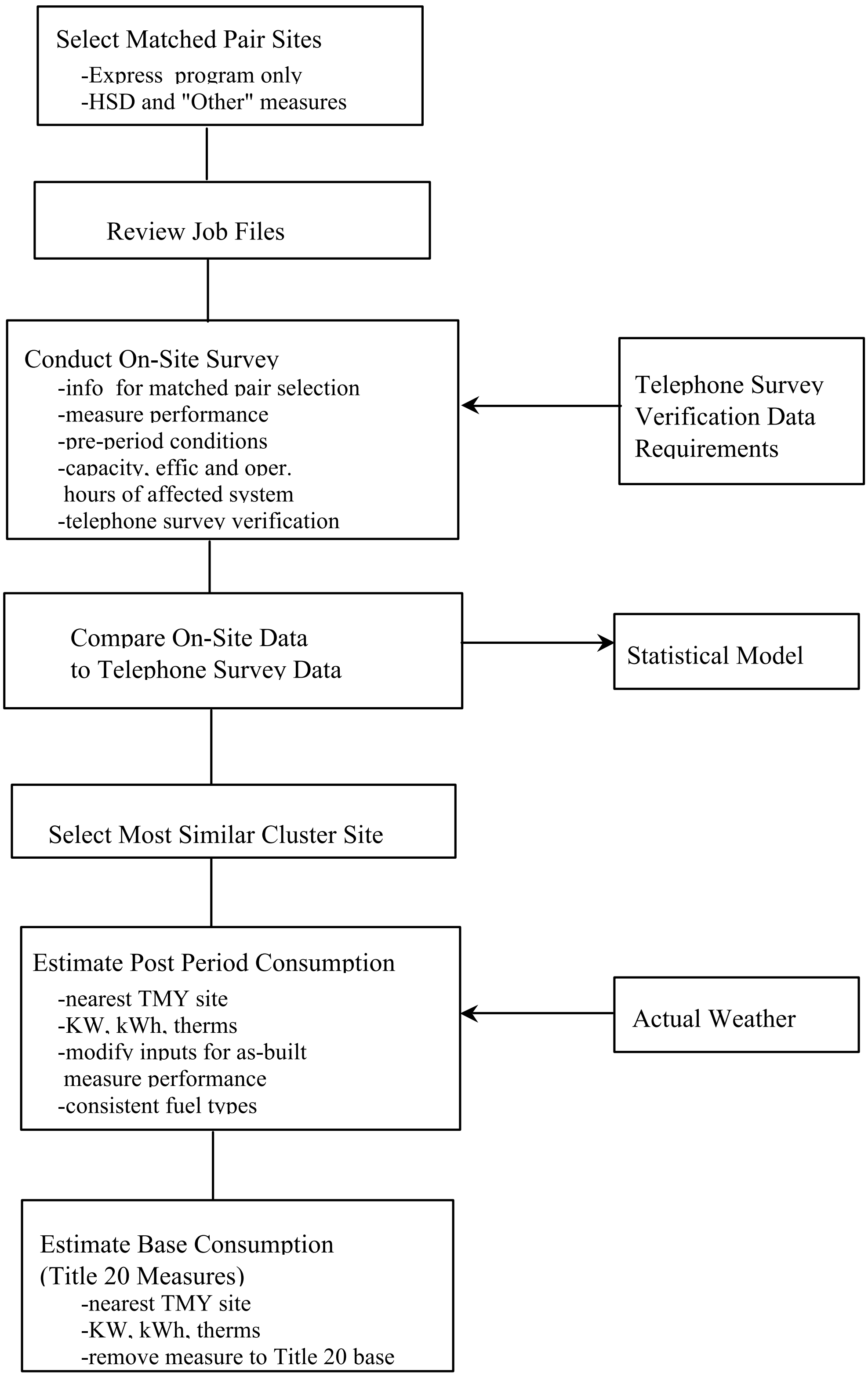
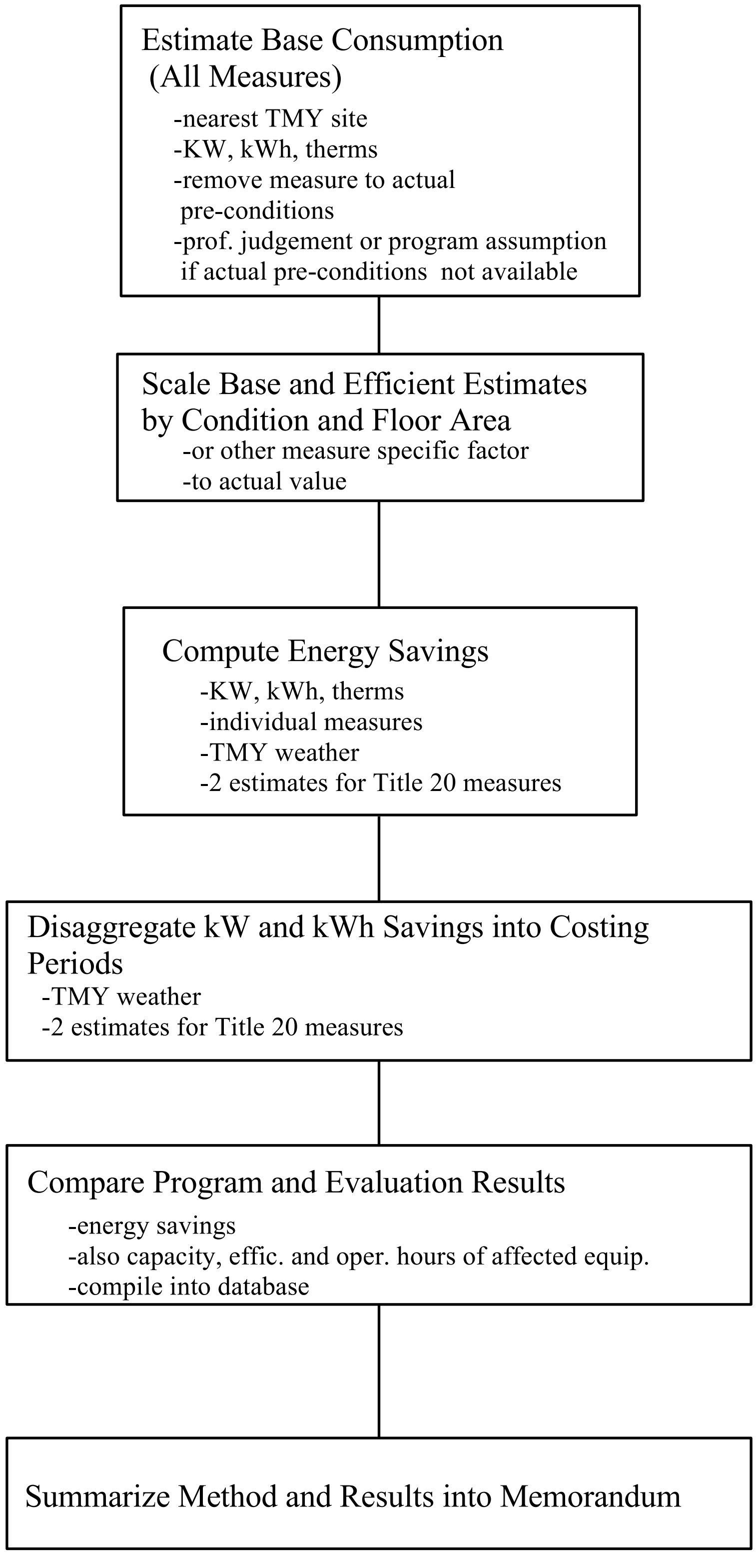


Figure V-2: Flow Diagram of Matched-Pair Analysis Procedures (continued)



Sources of Data

The data used for the two classes of analysis came from a number of specific sources available to the engineering analysts during and following the on-site survey. These sources included:

1. **Interview**. Field engineers interviewed building staff and operators. In addition, for some sites the responsible PG&E engineer was interviewed to clarify the nature and implementation of the measures at specific sites.
2. **Observation**. Field engineers carefully observed current conditions and equipment characteristics throughout the study area defined at each site.
3. **Catalog/Reference**. A wide variety of reference materials such as manufacturer's cut-sheets and the American Refrigeration Institute's equipment directories were used to obtain data on the characteristics of specific types of equipment, based on the make and model numbers recorded in the on-site survey.
4. **Construction Documents**. Building plans and equipment schedules were reviewed as available to determine various characteristics of the sites that could not be easily or accurately observed.
5. **One-time Measurements**. Measurements were made on a one-time basis at some sites to determine items such as lighting and equipment loads.
6. **Short-Term Measurements**. A series of short-term end-use measurements were taken at calibration sites to determine the utilization and energy consumption characteristics for specific types of equipment.
7. **Project File**. Documentation prepared by PG&E program staff during program implementation was used as a primary or secondary source of data for several important measure performance parameters.

Tables V-1 and V-2 show the sources which were used to obtain each data element required to calculate savings for the cluster and matched pair analyses, respectively.

Table V-1: Sources of Data for the Cluster Analysis of Gross Savings

Data Element	On-Site Interview	Observation	Catalog/ Reference	Construct. Documents	One-Time Measure	Short-Term Measure*	Project File
Pre/Post Measure Characteristics:							
Window shading coefficient	X	X	X	X			X
HVAC equipment type	X	X		X			X
Cooling fuels	X	X		X			X
Evaporative cooling parameters	X	X	X	X			X
Cooling equipment capacity	X	X	X	X			X
Cooling equipment efficiency			X	X			X
VAV box operating parameters	X	X	X	X			X
Heat/cool schedules	X	X	X			X	
Heat/cool setpoints	X	X				X	
Cooling tower capacity	X	X	X	X			X
Cooling tower operation	X	X		X			X
HVAC control features	X	X		X			X
Fan capacity		X		X	X		X
Fan operating parameters	X	X	X	X			X
Pump operating parameters	X	X		X			X
As-built Simulation Characteristics:							
Conditioned floor area				X	X		
Number of floors		X					
Envelope description		X		X			
Percent glazing		X		X	X		
Glazing type		X		X			
Lighting power density		X	X	X	X	X	
Lighting schedule	X					X	
Equipment fuel type	X	X		X			
Equipment power density	X	X	X	X	X	X	
Equipment schedule	X	X				X	
Heat capacity		X	X	X			X
Heat fuels	X	X					
Heat efficiencies		X	X	X			
Pump capacities	X	X	X	X			X
Air flow rates		X		X	X		X

* Short-term measurements are intended for calibration sites only.

Table V-2: Sources of Data for the Matched-Pair Analysis of Gross Savings

As-Built Measure Characteristics	Observation	Catalog/ Reference	Construction Documents	Project File
Window area with film	X		X	X
Count of affected units	X		X	X
Cooling equipment and capacity	X	X	X	X
Fan horsepower	X		X	X
Cooling system efficiency		X	X	X
Building type	X			X
Conditioned square footage	X		X	X

B. Participant Sample Recruitment and Program Document Review

A sample of participants was drawn according to the sample design agreed to with PG&E. This sample was drawn from a list of records extracted from the program data base that met all of the selection criteria described in the sampling plan. Once drawn, all of the information available on each project was saved in a sample control file. This file was used to track the status of each project throughout this research. The first stage of the telephone survey resulted in the recruitment of the 139 on-site survey participants, plus replacements.

As groups of participant sites were recruited via the telephone survey, their application numbers were submitted to PG&E to obtain a copy of the paper files for those applications. These paper files were reviewed by engineering staff, who obtained information on the pre- and post- conditions of each site and the specifications of the equipment associated with the PG&E rebate. If any of the files lacked sufficient detail on the type, quantity or location of affected equipment, the PG&E project manager was contacted, and if necessary, appropriate PG&E program staff were contacted for clarification. Program data base savings values for each measure were then compared to the savings estimate in the project files. Summary sheets were prepared for the sites that listed relevant site visit information obtained from the recruitment process, program file and data base savings values, and highlights of the information extracted from the program file. These summary sheets were passed to the member of the field engineering staff who was assigned the site.

C. Calibration and Test Sites

As described in Chapter IV, five calibration sites were selected to represent groups of the cluster analysis sites and three test sites that were used to assess the value of the clustering approach to energy savings estimation. Calibrated simulation models were prepaed for each of these sites using the data collected from the on-site survey, along with billed 1994/95 gas and electric consumption and actual 1994/95 hourly weather for the closest NOAA station (supplemented with PG&E temperature data). In addition, for each calibration site, the simulation model was calibrated to the short-term end-use metering data described in Section IV.

A site-specific calibration plan was developed for each calibration and test site. Per the specifications of this plan, the model was calibrated for each calibration and test site against actual consumption (kW, kWh and therms) for the post-installation portion of the 1994 summer cooling season (July, August and September). Simulation inputs were prepared using survey data. Short-term end-use metering data from the early part of the summer of 1995 was also used to establish realistic internal load schedules and control logic for the HVAC system in the five calibration sites. The development of a calibrated model for each calibration and test site began as soon as the short-term metering data from the calibration site became available.

For calibration sites, monthly and annual consumption for the lighting and equipment end uses were estimated from the short term measurements by extrapolating average consumption per day from the one to two week measurement period. Separate extrapolations were made for weekdays and weekends, if the short-term data showed significantly different consumption patterns for these two day types. The monthly estimates of these two end uses were also entered directly into DOE-2. Monthly and annual HVAC consumption was estimated by subtracting the estimated monthly and annual lighting and equipment consumption from the billing records (total consumption). Monthly estimates of HVAC consumption were summed for the three summer months. This summer HVAC value was the target against which the adequacy of the DOE-2 estimate of summer HVAC consumption was judged.

For the summer period the three-month estimate of HVAC consumption predicted by DOE-2 for each calibration and test site was calibrated to within 10 percent of the measured three month HVAC target. For each month in the calibration period (June 1994 to May 1995) the simulation was further calibrated to within 10 percent of billed consumption (all fuels). The model was successfully calibrated for all but one calibration site, where a natural gas billing history was not available.

The monthly calibration of electricity also included kW demand. The DOE-2 model was considered fully calibrated when it met the consumption (kWh) calibration criteria discussed above and the simulated monthly kW (total building) was within 20 percent of the monthly billed kW demand. Calibration to monthly demand was only performed at sites served by a single meter. The peak demands for two meters are not necessarily additive since the peaks may occur at different times. If more than one meter served a single site, then it became impossible to determine the overall site peak demand..

D. Cluster Analysis

Once each of the calibration and test site post-period models were complete, each of them was used to estimate typical base and efficient post-period use (gas and electric) for the corresponding cluster of cluster analysis sites. First, the calibration and test site models were used to estimate typical efficient post-period use for the calibration and test sites, respectively. This was accomplished for each site by substituting TMY (Typical Meteorological Year) weather for the actual weather year used for calibration. The models run with TMY weather provided estimates of typical efficient post-period use.

Next, for each of the calibration and test sites, the aspects of the HVAC system modified by the rebated measures were set to their pre-installation condition (e.g., automated controls are removed and a manual control schedule is imposed). Each model was run under these conditions to produce an estimate of base consumption. For measures that were affected by Title 20, a second estimate of base consumption was produced by changing the measure-affected aspects of the HVAC system to the appropriate Title 20 standard. Separate base consumption estimates were produced for each sampled measure.

A similar process was employed for other sites in each cluster. However, before the efficient case model for the calibration site was used to estimate savings for the HVAC measures at each site, it was modified to accurately reflect the site-specific conditions observed during the on-site survey. For each site, at a minimum, the HVAC system characteristics, operating schedules, internal load densities and schedules, and window area were modified to conform to site-specific characteristics. In addition, weather data for the NOAA location closest to each site was used in the simulation. Once the model was adapted to each site's characteristics, it was used to estimate efficient post-period use in the manner described above for test and calibration sites. Post-period use estimates were scaled based on floor area to account for differences between the floor area of the calibration site and the floor area of other sites in each cluster.

Billing histories, when available, were obtained for meters found in the on-site survey of all cluster analysis sites. These billing histories were for a period of up to one post-retrofit year and a minimum of two months of stable measure operation. For all cluster analysis sites (except the calibration), billed energy was compared to simulated consumption, based on the customized as-built DOE-2 model for each site, run on hourly weather data for the closest NOAA site (supplemented by PG&E weather data). Billed demand was also compared to simulated demand for all sites served by a single electric meter. As mentioned above, it was not possible to determine the peak demand for sites served by more than one meter since the individual meter peaks are not additive. All sites that did not match monthly consumption within ten percent (gas and electric) and monthly demand within 20 percent for the period covered by the billing history were examined. Changes were made to the simulation models to meet this matching criteria. After an acceptable match was achieved, systematic changes were applied from the test site analysis (see below) and the post-period model was rerun under typical weather conditions in preparation for the calculation of energy savings.

For each test site, the final post-period model (treated as other clustered sites) was rerun with TMY weather conditions. Base consumption was then estimated, using TMY weather, with the same procedure discussed above for the fully calibrated test site model. For each cluster, the predicted savings for the test site model were compared to the savings predicted by the calibration model modified to reflect the test site conditions. The reasons for any significant differences were determined and changes were made in all DOE-2 models for a given simulation site or cluster, as appropriate, were made to minimize these differences.

Base consumption for each of the other clustered sites was estimated using the same procedures discussed above for the calibration and test sites. Aspects of the HVAC system modified by the rebated measures were set to their pre-installation condition. Each cluster model was run under these conditions to produce an estimate of base consumption. The base case estimates were scaled based on floor area to account for differences between the floor area of the calibration site and the floor area of the other sites in each cluster. A second estimate of base consumption was also produced for each measure that was affected by Title 20 by modifying each model to reflect the appropriate Title 20 standard. Separate base consumption estimates were produced for each sampled measure.

E. Matched-Pair Analysis

Typical efficient post-period use (gas and electric) was estimated for each matched-pair site by modifying simulation inputs from its paired cluster analysis site to reflect the as-built condition observed at the matched-pair site for certain key variables. These variables include the as-built performance of the program measures selected for the matched-pair sites and other site specific inputs (including fuel types) that were primary determinants of energy consumption. The post-period simulation was run under typical weather conditions (nearest NOAA station) for the matched-pair site and typical post-period use was scaled by floor area.

For each matched-pair analysis site, typical base consumption (gas and electric) was then estimated by setting aspects of the HVAC system modified by the rebated measures to their pre-installation condition. Each model was run under these conditions and with typical weather to produce an estimate of base consumption. For measures that were affected by Title 20, a second estimate of base consumption was produced by setting the measure-affected aspects of the HVAC system to the appropriate Title 20 standard. Both estimates were scaled by floor area. Separate base consumption estimates were produced for each sampled measure.

F. Costing Period Electric Savings Estimates

The cluster or matched-pair analysis for each site, as outlined above, created two, and in the case of items affected by Title 20 standards, three DOE 2.1E models. These are described below:

1. **As-built model**: represents the lighting, HVAC, and operating conditions observed during the site survey, with particular attention paid to simulating the HVAC measure equipment as accurately as possible.

2. **Pre-condition model**: same as the as-built model, except that model parameters affecting the HVAC measure and operating conditions were changed to reflect equipment in place prior to measure installation.
3. **Title 20 model** (for Title-20-affected items only): for certain packaged air conditioning unit measures, the as-built model was modified by changing the measure equipment efficiency from the as-built value to the minimum efficiency mandated by Title 20.

As-built, pre-condition, and where appropriate, Title 20 models were run for each of the cluster analysis and matched pair analysis sites. Each of the models generated hourly electric demand estimates for a one-year period, along with an annual estimate of gas consumption. Using these hourly data sets, kW and kWh savings were computed as the difference between as-built and pre-condition consumption under typical weather conditions. Therm savings were calculated using annual totals. The DOE-2.1E hourly output files were also processed to determine the kWh and kW savings that occurred in each of the PG&E costing periods. Coincident kW savings were also calculated for the system maximum hours specified by PG&E for each costing period. For the summer on- and partial-peak costing periods, these savings were based on the five days with the highest demand savings. For the other costing periods, coincident kW savings were calculated from the average demand savings on weekdays. For the measures impacted by Title 20, a second estimate of savings was produced, in a similar manner, using the Title 20 base consumption estimate.

G. Annual kWh, kW, and Therm Savings Estimates

The hourly output files were also used to estimate item-level estimates of annual kW, kWh, and therm savings so that they could be compared to the estimates of savings provided in the program data base. Annual savings for kWh and therms were computed by summing the hourly savings for all hours of the year. For the measures impacted by Title 20, a second estimate of savings was produced, in a similar manner, using the Title 20 base consumption estimate. The demand (kW) savings estimates are based on the maximum demand during the summer on-peak costing period. This maximum demand is defined as the average of the five highest demand savings estimates for the item during the hour of maximum kW savings for all participants.

VI. Methodology for Statistical Analysis of Gross Impact

We estimated cross-sectional time-series models beginning with a pool of 438 participants who completed a telephone survey and whose data survived a variety of data screening activities. This pool also included 139 customers for which on-site surveys were completed. Chapters III and IV describe the data collection process and the disposition of the telephone interview and on-site survey samples. Appendix C describes more fully the data extraction process and the construction of the master statistical analysis file (MSAF) prepared from these surveys, PG&E's billing data and other data sources.

A. Participant Group

A participant is defined as a PG&E customer who received a rebate in 1994 for installing HVAC equipment through PG&E's 1994 retrofit programs. They may have installed one of two types of equipment that are referred to in some analyses: energy-using and non-energy-using equipment[1]. Note that a participant, as defined, could have installed the equipment in 1993 and been paid in 1994. 1994 participants could also have participated in 1993 programs (HVAC or lighting) and/or 1995 programs.

B. Model Specifications

We considered a variety of models depending on the quantity and quality of data available. Below are three of the general specifications that we explored. An important goal of our modeling effort was to use the best information available at the lowest level of aggregation.

$$E_{b,t} = \alpha_b + \sum_{k=1}^{K} \lambda_k X_{k,b,t} + \sum_{d=1}^{D} \beta_d ENG_{d,b,t} + \varepsilon_{b,t} \quad (1)$$

$$E_{b,t} = \alpha_b + \sum_{k=1}^{K} \lambda_k X_{k,b,t} + \sum_{d=1}^{D} \beta_d ENG_{d,b,t} + \sum_{d=1}^{D} \beta_d I + \varepsilon_{b,t} \quad (2)$$

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[1] Energy-using cooling equipment includes such technologies as air conditioners, chillers, evaporative coolers, cooling towers, pre-coolers, and HVAC motors. These technologies, in addition to providing cooling through the use of energy, vary in the efficiency with which they operate. Further, these technologies are generally assigned efficiency ratings, such as Energy Efficiency Ratings (EERs), Seasonal Energy Efficiency Ratings (SEERs), Coefficients of Performance (COPs), etc. Finally, while some of these EUCEs are not rated, they can be ordered relative to their counterparts as to efficiency. For example, evaporative coolers are not generally rated for efficiency level but they are considered more energy efficient than a comparable air conditioner under the right climatic conditions. Therefore, they too can be placed on an energy-efficiency continuum. The important issue that distinguishes this technology group is that customers choose to install one item within this group and that item falls somewhere on the efficiency continuum.

The second technology category is composed of items that do not consume energy, but inherently conserve it. They will be referred to as non-energy-using equipment and include such things as ASDs, time clocks, EMSs, setback thermostats, and reflective window film.

$$E_{b,t} = \alpha_b + \sum_{k=1}^{K} \lambda_k X_{k,b,t} + \sum_{d=1}^{D} \beta_d I_{d,b,t} + \varepsilon_{b,t} \tag{3}$$

where

E	=	recorded energy consumption of building b at time t
α	=	premise-specific intercept
γ	=	a vector of estimated coefficients that reflects the average change in overall energy consumption that would result from a one-unit change in X_1
X	=	a vector of site- and time-specific variables related to energy consumption
β	=	a domain-specific coefficient associated with an engineering prior or with an installation dummy variable
ENG	=	engineering estimate (enhanced or otherwise) of savings for HVAC measures
I	=	dummy variable indicating the installation of HVAC equipment
ε	=	captures the energy consumption not explained by the model
d	=	subscript indicating domain-specific values

Each of these specifications will be briefly discussed below.

The first specification incorporates separate engineering priors for energy using and non-energy using HVAC meta-domains. The advantage of this approach is that it attempted to use as much prior engineering information as possible. The information included the *enhanced* engineering priors developed for the engineering analysis sample as well as the engineering priors from the PG&E Program Database for measures not included in the engineering analysis sample. Before inclusion into the model, these latter priors were adjusted using information gathered from the on-site surveys. These priors are referred to as *improved* priors. The estimated βs in this model represent the so-called realization rates, i.e., the amount of the expected gross kWh savings achieved or realized. This model as well as the other models listed used premise-specific intercepts (a fixed effects model) in order to better capture building specific effects and reduce the model's noise.

The second specification used only the enhanced engineering information, developed for the engineering analysis sample, and dummy variables representing the other installations that did not receive treatment in the engineering analysis. This was done because we had concerns regarding the amount of measurement error contained in these adjusted priors. In this model, the estimated βs associated with the enhanced engineering priors represent the realization rates while the βs associated with the installation dummy variables represent estimates of the gross kWh impacts.

Finally, the third model was estimated as a point of comparison to the SAE models or to use as our only estimate if the SAE models failed to yield plausible results[2]. This model incorporates a dummy variable indicating the installation of HVAC equipment. In this model, the estimated βs associated with the installation dummy variables represent estimates of the gross kWh impacts. Of course, all three models

[2] Our main concern is that measurement error in either the enhanced priors from the on-sites or the PG&E engineering priors adjusted using information from the on-sites will bias our estimates of gross savings. A brief discussion of measurement error in the context of SAE models is contained in Appendix I

include a variety of other data from on-sites and telephone surveys, and the Program Database. Economic and weather data were also included in all models.

C. HVAC/Lighting Interaction

The Protocols require that the interaction effects of installing both efficient HVAC equipment and efficient lighting equipment during a given program year also be estimated. While our main interest here is in the relationship of HVAC installations with kWh consumption, we also realize that the amount of HVAC consumption is often moderated by the presence of lighting installations at the same site and at approximately the same time. In the estimation of any one of the basic gross impact models (Eqs. 1-3) such interaction effects can be estimated. Consider Eq. 3 to which has been added a multiplicative term representing the interaction of these two end uses.

$$E_{b,t} = \alpha + \sum_{k=1}^{K} \lambda_k X_{k,b,t} + \sum_{k=1}^{K} \beta_k HENG_{k,b,t} + \sum_{k=1}^{K} \beta_k (HENG_{k,b,t} * LENG_{k,b,t}) + \varepsilon_{b,t}$$

Ordinarily, it would be useful to obtain the effects of installing only lighting equipment so that the main effects of each end use could be estimated and then their interaction. However, this study was limited to the investigation of those participants who received a rebate for HVAC measures; some of whom also installed lighting. Program participants who were paid a rebate from PG&E for installing only lighting are being studied in another evaluation.

Form of the Interaction

While the simple product term described above allowed us to test the presence of a "moderated" relationship, there are in principle a wide (perhaps infinite) variety of moderated relationships. That is, even if the interaction term is not statistically significant, this does not necessarily mean that there is no interaction. It may mean only that there is an alternative form of the interaction, rather than the bilateral form illustrated in the above equation. The challenge in this study was to correctly specify the form of the interaction and then to test its significance. To this end, we created a variety of terms to capture the particular form of the interaction.

We tried interacting the enhanced priors with the lighting priors from the Program Database. This produced some rather large numbers since the priors for both lighting and HVAC for a given premise could be large. In various regression models, a substantial number of premises were identified as influential observations simply because of the magnitude of this independent variable. We also tried interacting a dummy variable indicating the installation of HVAC equipment with the engineering prior for a lighting installation. The form of the interaction that was eventually used involved multiplying the dummy variable representing the installation of a program-related HVAC and a dummy variable representing the installation of a lighting measure.

D. Data Description

Dependent Variable

The dependent variable in the time series models described above is the recorded monthly kWh consumption for the participating premises from 1/92 through 9/95.

Explanatory Variables

The vector of explanatory variables is comprised of several categories. These variables fall into six groups:

1. Engineering priors
2. Equipment rebated through the program (1994)
3. Equipment installed outside of the program (1992 through 1995)
4. Changes in business other than equipment installations
5. Weather information
6. Economic indicators
7. Business and building variables that did not change

The treatment of each group of variables is discussed below.

Engineering Priors. Consistent with the findings of Sonnenblick and Eto (1995), our SAE approach began with an effort to reduce the uncertainties in savings estimates through the use of detailed site inspections, metering, and DOE-2.1E analyses, as described in Section V. First, recall that a total of 139 participant on-site surveys were conducted to produce improved estimates of the gross savings. These improved estimates are referred to as *enhanced engineering priors* or simply *enhanced priors*. Of these 139, 60 were cluster-analysis sites and 79 were matched-pair sites[3]. It was expected that this effort would reduce both random *and* non-random error in the savings estimates for the 139 sites.

The challenge was to leverage the enhanced priors for the 139 sites in order to minimize the systematic and random error for all 438 sites and thus to reduce the bias in estimated realization rates. Since we estimated the gross models on all 438 premises, we needed to extrapolate the enhanced priors to the other 311 customers who did not receive an on-site survey. To do this, we used a calibrated engineering (CE) model (Violette and Barnes, 1994). The CE model can use either a single ratio approach or a regression approach. The single ratio approach involves first calculating the ratio of the enhanced engineering-based estimates of gross savings to the original PG&E engineering-based estimates of gross savings contained in the Program Database. This ratio is in effect a realization rate. Next, each PG&E estimate was then adjusted up or down by multiplying it by this ratio. This adjustment for the other 311 customers is in effect a prediction of what the enhanced estimates would have been had these other 311 customers also received on-site surveys and subsequent simulation analysis.

The regression approach involves first estimating a regression model of enhanced engineering estimates of gross savings as a function of PG&E's savings estimates and other customer characteristics. This model would then be used to simulate engineering priors for the 311 customers that did not receive on-site surveys. The advantage of the latter approach is that customer characteristics, not just the enhanced and PG&E priors that constitute the ratio, can be used to improve the prediction of what the enhanced priors would be for those 311 customers who did not receive on-site surveys.

Ultimately, we chose the ratio approach due to low correlations between the original PG&E prior and the enhanced estimates for the 139 sites. Table VI-1 presents these correlations by domain. The low

[3] See Section V for a complete definition of Calibration, Cluster and Matched-Pair sites.

correlations shown in the table mean that the predictions of enhanced priors produced by a regression model would have contained a fair amount of error.

Table VI-1: Correlations Between Enhanced Engineering Priors and Program Database Engineering Priors

Use Group	Domain	Measure Description	Title 20	On-Site Survey N	Program Population N	Pearson R
Non-Energy Using Measures	2	ASD HVAC fan	NO	15	27	0.37535
	3	convert to VAV	NO	3	4	0.97457
	6	excluded HVAC	NO	0	46	.
	8	ASD HVAC	NO	6	20	0.61179
	9	HVAC other	NO	15	148	-0.02845
	9	HVAC other	YES	1	23	.
	11	EMS	NO	12	42	0.99751
	13	window film	NO	27	153	0.67987
Energy Using Measures	1	central AC	YES	30	235	0.61923
	4	cooling tower	NO	25	33	0.25905
	5	evap cooler	NO	7	14	0.55466
	6	excluded HVAC	NO	0	5	.
	9	HVAC other	NO	0	6	.
	10	HVAC resize motor	NO	2	3	1
	14	chiller air cooled	NO	5	10	-0.04139
	15	chiller water cooled	NO	17	28	0.75132
Lighting Non-Energy Using	12	Non HVAC other	NO	0	99	.
Lighting Energy Using	12	Non HVAC other	NO	0	742	.
	12	Non HVAC other	YES	0	232	.
Other	12	Non HVAC other	NO	0	66	.

Thus, *per domain*, enhanced estimates and the corresponding PG&E Program Database estimates were compared and their aggregate ratio applied to the other measures. When there were insufficient numbers within a given domain to support a robust extrapolation, a more aggregate ratio obtained over all measures within the applicable “meta-domain” (energy-using or non-energy-using) was used. In the case in which the measure was affected by Title 20, the estimated savings represent the difference between Title 20 and the new efficient equipment, which represents the savings on which PG&E can earn a financial return. However, because this difference will be much smaller than the expected reduction observed in a customer’s kWh consumption, this prior would not perform very well in an SAE model. Thus, for Title 20-affected measures, a ratio of the difference in usage between the old equipment and the new equipment *to* the difference in usage between Title 20 and the new equipment was calculated and used to make the appropriate adjustments.

Another important issue stemmed from the fact that the PG&E estimates of gross savings are annual rather than monthly. If one wishes to use a monthly model, then one must allocate the annual savings to months in a manner that recognizes any patterns such as those associated with seasons. Aggregation of the measure estimates from the DOE 2.1E simulation analyses, by typical month, served as a useful method to allocate PG&E kWh savings estimates across months.

Equipment rebated through the 1994 program. The installation variable in the time series models described above is zero in the months before the installation. In the month in which the installation took place, the zero converts to the engineering prior and continues to the end of the series. Methods of dealing with any error associated with this presumed installation date are described later in this section.

Equipment installed outside of the program. Both participants and non-participants could and did install equipment outside of the 1994 program (before, during and after the program period), and we can expect an effect on kWh consumption to result. Such installations can of course help to explain any of the observed changes in consumption over time. Therefore, it becomes important to model the effects of these installations. Information for this purpose was collected in two ways. First, equipment installed under 1992, 1993 and 1995 rebate programs were identified through the program database. Second, information on non-rebated installations spanning the 1992-1995 time period was gathered during the telephone interview. Data collected during the telephone interview included the following:

Rated, Energy-Using HVAC Equipment

- Cooling equipment -- Replacements
- Cooling equipment -- Additions
- Heating equipment -- Replacements
- Heating equipment -- Additions

Unrated, Non-Energy-Using Technologies

- Adjustable speed drive -- Additions
- Energy Management Systems -- Additions
- Time Clock -- Additions
- Setback Thermostat -- Additions

Lighting Equipment

- Lighting fixtures -- Replacements
- Lamps -- Replacements
- Lamp removals

For each of these equipment items, the month and year of installation was elicited from the respondent. This was important because the time of installation is heavily related to the effect it will have on the change in consumption. For example, if an EMS was installed at the same time that the rebated equipment was installed, the EMS installation would help to explain the drop in consumption. If, on the other hand, it was installed at the beginning or end of the analysis period, it would explain relatively little of any changes in consumption from the pre to the post period. Because of this pattern of potential effects, it was considered important by the investigators to take the date of extra-program installations into account in modeling the change in consumption over time. Thus, the switch from a zero to a non-zero value in the monthly series occurred in the month of each installation.

Changes in businesses other than equipment installations. Another type of change, unrelated to the program, but that can affect the observed changes in consumption over time, are changes in floor area (increases or decreases in square feet) and changes in business hours (increases or decreases in number of business hours). For those premises reporting such changes, the variable begins with the value of zero. At the month during which the change occurred, the variable converts to the value of the reported change.

For example, if a premise reported that in November of 1994 it reduced its business hours by 15 hours per week, the value of the variable would convert from a zero to 15 on November of 1994.

Both changes in square footage and business hours were measured by asking the respondent to indicate what the square footage was before and after the change. The same is true of business hours. The differences were calculated to use in this analysis. More specifically, business hours were measured by asking the respondent what the business hours were each of the seven days of the week, and holidays. These responses were converted into number of business hours per week.

Weather information. Cooling degree day set points were used according to the table in Appendix C which were specific by building type and reflect engineering data and observations. However, the file also contained set points five degrees above the standard for the building type and five degrees below so that the effect of other set points might be explored if necessary.

Heating degree day set points were not available for specific building types. Therefore, a constant set point of 60 degrees was used.

Economic indicators: capturing trend effects. Several macro-economic indicators were acquired for the purpose of accounting for the separate effect of prevailing economic conditions on consumption. First, commercial employment figures were obtained in a quarterly format; they were provided in three sectors: (1) finance, insurance and real estate, (2) services, and (3) trade. The three employment areas were partitioned into 12 months for each evaluation year, beginning with 1992, and they were summed across the three to form one total measure of employment. The information was provided by Metropolitan Statistical Area (MSA), and the appropriate employment figures were assigned to each sample premise based on its MSA.

A second economic indicator that was collected was quarterly taxable sales. These quarterly figures, too, were divided into three equal parts to conform to the monthly approach of this model. These figures were also supplied by MSA.

A third indicator is the real per capita personal income, provided quarterly by MSA. A fourth variable, the California Consumer Price Index was also provided. This variable is in quarterly units, but is not separated by MSA; it is a statewide variable. Therefore, the CPI does not vary by the geographic location of the sample businesses. In every other respect, however, it was prepared for the analysis file in the familiar manner.

A final indicator of customer reactions to economic conditions as well as to social/political and weather conditions was developed specifically for this project. It was reasoned that electricity consumption over all PG&E premises would vary with economic and other historical conditions. During recessions, consumption will decrease, and when business is good, electricity use will increase. However, both economic conditions and consumption will vary by business type and climate. Based on this reasoning, premise-level, commercial sector consumption was aggregated by SIC to conform to the CEC-based categories of building type. In addition, aggregation included a CEC climate zone so that each kWh value represents the combination of a two-digit SIC category and a climate zone. Therefore, a value appropriate to each sample member's business type and climate zone was assigned. This information is, of course, available in a monthly format. In summary, this variable was included in the model to explain variation in consumption over time for reasons other than the central installation variable. That is, this variable attempted to capture the effects of economic, historical, social, and weather conditions that are unknown to us or, if known, could not be explicitly modeled.

Building and business variables that did not change. Other variables that did not change over time were included in the analysis because of their ability to explain base energy consumption. The first such variable is building type. The original analysis file contained 16 CEC-defined building types. However, where there were fewer than 25 in a category, that category was included with another or was included in the miscellaneous group. They were translated into a series of dummies with one omitted category. Another key non-change variable was current conditioned square footage.

E. Pre and Post Definitions

In utility evaluations, it is usually quite challenging to operationalize, particularly for program participants, the pre and post installation periods[4]. In the program database, there are a number of dates associated with a number of events in any given installation's history. However, there is a fair amount of uncertainty surrounding the extent to which these dates accurately reflect the dates of the actual installations. Table VI-2 below presents the key dates that were used to estimate the installation dates and a brief description of each.

Table VI-2: Key Dates in Program Database

Date	**Description**	**Participant Installations Having Date**
Paid Completion	The date on which the rebate was paid	8%
Project Completion	The date on which the project was completed	10%
Authorization	The date on which PG&E authorized the rebate payment	100%

As a rule, for a customer who has all three dates, the Authorization Date is the earliest date, followed by the Project Completion Date and the Paid Completion Date. It is assumed that, for a given customer, the equipment installation occurred *before* and *closest* to the latest date in the Program Database. Thus, when assigning the installation date, we assigned the Paid Completion Date if it was non-missing. If it was missing, we assigned the Project Completion Date. If that was missing, we then assigned the Authorization Date. As one can see from the third column of Table VI-2, the Paid Completion Date was missing for 92% of the installation. The Project Completion Date was missing for 90% of the installations. Finally, the Authorization Date was always present. Thus, the third column of Table VI-2 also represents the percent of the installations in our participant sample that were assigned each of these three dates as the installation date.

Once the dates were assigned, we set the dead band around each estimated installation. Such a decision poses a dilemma. To err on the liberal side and deadband too much while certainly minimizing any ambiguity regarding pre and post installation will also reduce the amount of data available. On the other hand, to deadband too little while preserving data leaves a fair amount of ambiguity regarding pre and post installation. For each customer, we set an asymmetrical deadband because we were virtually certain that the installation occurred before the latest date in the Program Database. could not have happened

[4] For non participants, we were forced to rely solely on self reports regarding what may have been installed and the date(s) of installations.

prior to the authorization data. The length of the deadband was three months which included the installation month and the two months preceding the installation month.

Once the models were estimated that used the initial assignment of the installation date based on the presence of Paid Date, Project Completion Date, and Authorization Date, they were re-estimated (not necessarily re-specified) with the appropriate deadband in place. Any significant differences in model results prompted an additional round of model specification and estimation.

F. Attrition Bias

In any data collection effort, there will be non respondents, i.e., those who were selected to be in the sample but are either unavailable or unwilling to respond, or are unfit for a variety of reasons having to do with the quality and/or quantity of their kWh data. These non-respondents are often not representative with respect to the variable of interest. In such a situation, the sample mean of the respondents would be biased as an estimate of the population parameters. Beginning with the creation of the sample frames for both the participants and the non-participants, attrition has taken place for a variety of reasons, possibly affecting the representativeness of the achieved samples of 450 participant and 450 non-participant respondents to the telephone surveys.

To detect any attrition bias, we compared the respondents to the telephone surveys to the larger customer pools from which they were originally drawn. They were compared with respect to annual consumption, building type, and CEC climate zone. Analysis of variance, chi-square, and Fisher's exact test were used to determine if any of the differences were statistically or practically significant. The results of this analysis, shown in Appendix D, indicated that there was no significant attrition bias.

G. Self-Selection Bias

Some have argued that not including an inverse Mills ratio in the model involving only participants inevitably produces biased estimates. We argue here that if one is interested in estimating the first-year gross impacts, all things being equal, the estimate is unbiased. While it is true that participants in any given year will self-select into the program, we are only interested in estimating the impact on these participants. Certainly, forecasters and DSM program planners are interested in the extent to which one can generalize the impacts estimated for a given program cohort to future program participants, but this is not the objective of this program evaluation. Therefore, we did not include an inverse Mills ratio in this analysis.

H. Regression Diagnostics

We validated the robustness of the models by performing a variety of diagnostic checks referred to in the Quality Assurance Guidelines (Ridge et al., 1994). Checks were conducted for measurement error, outliers, heteroskedasticity, and autocorrelation, using methods described by Kennedy (1992), Pindyck & Rubinfield (1981), and Belsey et al. (1980).

Measurement Error

Because measurement error can result in biased savings estimates, special attention was paid to these problems. The primary focus of our efforts was on the key independent variable, the engineering prior. A more detailed description of this problem and our solution are described more fully in Section IX of this report.

Heteroskedasticity

Heteroskedasticity refers to the situation where the variances around estimates are different for different levels or values of the predicted independent variable. This problem is common in cross-sectional analyses, but does not result in biased estimates; rather, it results in inefficient estimates. The first step taken to identify this problem was to plot the residuals against the predicted independent variable. This allows visual identification of situations where the differences between predicted values and observed values are larger at some points of the regression line than others. Most commonly, heteroskedasticity takes the form of larger variances for higher values of the independent variable. The Modified Glejser test and the White test. Were employed to detect heteroskedasticity.

The eventual correction for heteroskedasticity is not predictable. The correction depends on the form of the relation between the independent variable and the predicted variable. The researcher tries different corrections for different functional problems and evaluates the results to determine whether the correction is appropriate. Sometimes the problem can be corrected or reduced by adding variables to the model that will explain the additional variance. Other methods used to address the issue are described in the Section XI which presents the results of this SAE modeling of gross savings.

Outliers and Influential Observations

The ordinary least squares method is very susceptible to the influence of cases that have extreme values. The bulk of the cases may be clustered in a rather tight area, with one case residing far away from the rest on the independent variable. This extreme case would have a very strong impact on the estimate of the regression coefficient, and would result in a biased estimate. Because of this influence on the prediction, such cases often cannot be detected by visual inspection or by observation of errors. This is because the prediction "line" may be close to the outlier *because* of its influence. However, graphical observation can still be used to look for potential influential cases. Another common method is the DFFITS procedure which calculates a predicted value two ways, once with a potential influential observation and once without it. If there is a large difference between the two, the case is considered influential.

A second test also estimates the model with and without the observation and then the difference between the two coefficients reflects the degree of influence. This is the DFBETA difference. These methods were employed in the current analysis toward detecting and correcting for influential cases.

Multicollinearity

Multicollinearity refers to the situation where two or more independent variables in a model are highly intercorrelated. This level of intercorrelation causes difficulties in the model. Specifically, multicollinearity results in higher variances for both predicted and explanatory variables. It also creates difficulty in partitioning variance among the competing explanatory variables. First, however, the problem must be detected. There are several ways to approach this task.

The simplest method to begin searching for multicollinearity is to compare the significance probabilities (p values) associated with the overall model compared to the p values for the partial coefficients for the explanatory variables. If there is a large discrepancy, multicollinearity should be suspected. In other words, if the overall model fits the data very well so that the p value is very small (e.g., .0001), but the p values for the individual coefficients are substantially larger, this indicates that variance cannot be partitioned into the various explanatory factors, and this implies strong linear relations among them.

Another approach to detecting multicollinearity is to test for variance inflation factors. A way to do this is to regress each explanatory variable on all other variables in the model. This allows the investigator to calculate a variance inflation factor by this equation:

$$\frac{1}{(1-R_i^2)}$$

where R_i^2 is the coefficient of determination for the regression of the ith independent variable on all other independent variables. This result is a measure of the instability of the coefficient estimate. Meyers (1990) indicates concern when values exceed 10.

Another approach to detection is recommended by Belsley et al (1980, chapter 3) and involves the analysis of structure. This approach entails the eigenvalues of the correlation matrix of the set of independent variables. The square root of the ratio of the largest to smallest eigenvalue is called the condition number which provides a single statistic for indicating the severity of multicollinearity.

Once detected, there is no consensus on what to do about it. Some recommend doing nothing. Others recommend obtaining more data, which, given both time and budget constraints, is unfeasible. Omitting one of the variables implicated is perhaps the most common approach. However, this makes sense only if the true coefficient of the omitted variable is zero. If the true coefficient of that variable is not zero, however, a specification error is created. Yet another approach is to group the collinear variables together to form a composite index capable of representing the group of variables by itself.

The various approaches that we took were a function of the specific situations we encountered in the analysis. In the results section, we describe our specific approaches to the problems and provide rationales.

Autocorrrelation

In time series models, it is often the case that an important assumption of ordinary least squares (OLS) is violated. Specifically, it is that in repeated sampling from the population, the correlation between any pair of disturbance terms across the conditional disturbances is zero. The violation of this assumption results in less *efficient* (not minimum variance) parameter estimates, although the parameters themselves are unbiased. The practical implications are that interval estimation and hypotheses testing can no longer be trusted. To detect any autocorrelation, we relied upon the Durbin-Watson (DW) statistic. In cases where autocorrelation was present, we transformed the data using values produced by the Hildreth-Lu search procedure.

I. Analysis Weights

Three different sets of weights were calculated for participants. The first returns the number in the achieved sample of 438 participants. The second returns the achieved sample of 139 participants who received on sites. The third returns the population of 1,094 participant premises. Each is described in detail in Appendix H. The application of each of these weights was a function of the analysis task at hand. Thus, how these weights were applied and with what purpose is described in Chapter XI.

J. Resolution of Differences

We also attempted to resolve or explain any differences between our impact estimates and the program's design estimates of savings. This information is potentially very useful to DSM program planners who need to know, for example, whether the gross savings calculated for each customer are reasonably accurate.

K. Weather Normalization

There are two basic approaches to producing weather normalized estimates of gross impacts. The first is to weather normalize the kWh data first and then estimate models using the weather normalized kWh data as the dependent variable. Having taken out the effect of abnormal weather, *typical* weather can of course still play a role in the models. The other is to estimate models using recorded kWh in which *observed* weather can play a role. Once the model has been estimated, it can be evaluated using normal weather. We have chosen the latter approach.

We have chosen this approach for several reasons. First, we were concerned that by weather normalizing first, not only the effect of abnormal weather was removed but also perhaps some unknown portion of the program effect. For example, if one first weather normalized the kWh consumption data before the installation and then weather normalized kWh consumption after the installation, the coefficients on CDD for the pre period might be different than the coefficient for CDD in the post period. Of course, this difference could reflect differences in weather sensitivity. However, if could also at least partially reflect the fact that the new HVAC equipment uses less kWh and is interpreted as lower weather sensitivity. Thus, to weather normalize may inadvertently remove some portion of the program effect. The solution was to estimate the model(s) using observed consumption and controlling for, among other things, the weather observed during the analysis period.

The fact that we are using SAE models has introduced another related concern. This concern springs from the fact that PG&E's estimates of savings are weather normalized as are the enhanced priors that resulted from our on-site surveys and DOE 2.1E analysis. On the face of it, to regress observed kWh consumption on an engineering prior that is weather normalized would be unfortunate since each customer-specific prior, depending on the weather experienced by each customer as well as their weather sensitivity, will be an over- or under-estimate of the expected savings. Thus, before using them in our regression models, we adjusted the weather normalized prior to reflect what the prior would have been under observed weather conditions.

In order to transform the typical weather priors for use in our regression models, the following procedures were followed. For all measures in the on-site survey sample, weekly data were provided, including typical meteorological year (TMY) cooling degree days, and engineering estimates of total consumption under base and observed measure implementation conditions. For each of these 51-week trajectories, very simple regressions were conducted to obtain rough estimates of the weather responsiveness of savings. For each "meta-domain" (HVAC energy-using, HVAC non-energy using), and for single domains where there were 20 distinct measures available, per-measure log-log regression results were examined, and the median coefficient values were used for later work in de-weather normalizing ex-ante estimates.

The coefficients, which give the percentage change in savings expected for a percentage point change in cooling degree days, were used, on a domain-specific basis, to modify the savings estimates to reflect likely savings in each month of the 45 billing periods comprising the study. Given the weather elasticity obtained from the data derived via DOE 2.1E simulation analyses, it was possible to consider a given monthly disaggregation of a measure's savings, and then apply the regression coefficient to the ratio of observed cooling degree days for that month to the TMY cooling degrees. The result thus obtained was applied to the monthly ex-ante to achieve weather-denormalization.

Once these final model(s) were estimated, they were used to forecast gross impacts under normal weather conditions. More specifically, the estimated model(s) were evaluated (simulated) using typical meteorological year (TMY) data from the National Oceanographic and Atmospheric Administration (NOAA).

L. Load Impacts and Impacts by Costing Period

Estimation of kWh and kW impacts by costing period were calculated based on results of the engineering analysis of on-site survey data. The engineering analysis produced building-specific baseline and efficient hourly load shapes. These load shapes, after reconciliation with billing data regression results, provided sufficiently detailed information to specify impacts by costing period.

M. Adjusting for State and Federal Efficiency Standards

To adjust estimated gross impacts to account for efficiency standards, we used the results of DOE-2.1E analyses for those installations affected by Title 20 standards. For these installations, three DOE-2.1E runs were conducted to produce HVAC usage for:

A. with the old replaced equipment in place

B. with the equipment in place that meets the Title 20 standards

C. with the new efficient equipment in place

The ratio of (A - B)/(A - C) represents the effect of Title 20 and were used to make final adjustments to the realization rates for affected equipment.

N. Data Dictionary

Following is a description of the variables that are used in the billing regression analyses of gross savings.

Variable Name	Variable Description
ADDAC	Coded 1 if cooling equipment added outside program in given month
AGGKWH	Monthly kWh of 228,000 premises divided into 2-digit SIC and climate zone groups, with appropriate value assigned to each sample premise.
AGGSIC3	PG&E consumption & 3-digit SIC
AUDIT	Month received audit from PG&E
BUSHRS	Business hours
CDD	Cooling degree days
CDD65	Monthly cooling degree days for closest weather station for each sample premise: Base 65°F
CDD70	Monthly cooling degree days for closest weather station for each sample premise: Base 70°F
CDD75	Monthly cooling degree days for closest weather station for each sample premise: Base 75°F
CHGBUSHR	Change business hours for a given month
CLINIC	Coded 1 if premise is a clinic, -1 if misc., 0 otherwise.
COMSERV	Coded 1 if premise is commercial services, -1 if misc., 0 otherwise.
CONDSQFT	Conditioned square footage
CPI	Monthly California Consumer Price Index for 1992-1995
EENG	Enhanced engineering prior beginning in month installed for 139 sites
EMPLOY	Monthly commercial employment rates by MSA for 1992-1995
EMSADD	Month in which EMS added outside program
ETOT	Employment in California
EUHN94C	On-sites survey non-energy-using equip x cooling degree days
EUHN94D	Non-energy-using equip, on-site surveyed
EUHN94L	On-site surveyed non-energy-using lighting measure
EUHU94C	On-site surveyed energy-using equip x cooling degree days
EUHU94D	Energy-using equip, on-site surveyed
EUHU94L	On-site surveyed energy-using lighting measure
FIXREP	Replacement of lighting fixtures in any given month outside program
FOOD	Coded 1 if premise is a food store, -1 if misc., and 0 otherwise.
GLM_MEAN	Premise-based mean consumption
HDD50	Monthly heating degree days for closest weather station for each sample premise: Base 50°F

Variable Name	Variable Description
HDD55	Monthly heating degree days for closest weather station for each sample premise: Base 55°F
HDD60	Monthly heating degree days for closest weather station for each sample premise: Base 60°F
HDD60	Heating degree days-set point 60 degrees
HOTLMOTL	Coded 1 if premise is a hotel or motel, -1 if misc., 0 otherwise.
HVACA	HVAC added in a given month outside program
HVACOP	Operation of HVAC system in non-business hours
HVACR	HVAC replaced in a given month outside program
HVACRN94	Replacement of HVAC with PG&E rebate in 1992, 1993, and 1995
KWH	Monthly recorded kWh consumption
LESHRS	Coded 1 if business hours decreased, 0 otherwise
LITOP	Operation of lights in non-business hours
MANAGE	Who manages building
MORHRS	Coded 1 if business hours increase, 0 otherwise.
OCCUPY	Portion of building occupied
OFFICE	Coded 1 if premise is a large or small office, -1 if misc., 0 otherwise.
PART2	Coded 1 if 1994 HVAC program participant, 0 otherwise.
PENG	Original PG&E engineering prior beginning in month installed
PERSREP	Coded 1 if premise is a personal repair business, -1 if misc., 0 otherwise.
PKHN94C	Non-on-site survey non-energy-using equip x cooling degree days
PKHN94D	Non-energy-using equip, not on-site surveyed
PKHN94L	Non-on-site survey non-energy-using lighting measure
PKHU94C	Non-on-site survey energy-using equip x cooling degree days
PKHU94D	Energy-using equip, not on-site surveyed
PKHU94L	Non-on-site surveyed energy-using lighting measure
PROGRAM	Customized or Express
REBLIT	Replacement of lighting fixtures in any given month with PG&E rebate in 1992, 1993, and 1995
REMLIT	Removal of lights in any given month
REPLAMP	Replacement of lamps/bulbs in any given month with PG&E rebate in 1992, 1993, and 1995
REPLIT	Replacement of lamps/bulbs in any given month outside program
REST	Coded 1 if premise is a restaurant, -1 if misc., 0 otherwise.
RETAIL	Coded 1 if premise is a large or small retail store, -1 if misc., 0 otherwise.

Variable Name	Variable Description
SCHED	Electric rate schedule
SCHGHRS	Cumulative hours changes scaled by customers consumption
SCHGSQF	Cumulative changes in square footage scaled by customer consumption
SCHOOL	Coded 1 if premise is a primary or secondary school, -1 if misc., 0 otherwise.
SEPMET	Business separately metered
SETASD	Month in which ASD added outside program
SETBACK	Month in which setback thermostat added outside program
SETIM	Month in which time clock added outside program
SIC	SIC code
SQFTCHG	Change in condition square footage for a given month
SUMH	Number of measures installed per month (energy-using, or non-energy-using) outside the 1994 HVAC program.
SUMHN	Number of non-energy-using measures installed in any given month outside the 1994 Retrofit Program.
SUMHRS	Amount of increases or decreases in business hours in any given month
SUMHU	Number of energy-using measures installed in any given month outside the 1994 Retrofit Program (includes lights,
TENURE	Own or lease place of business
WARE	Coded 1 if premise is a refrigerated or non-refrigerated warehouse, -1 if misc., 0 otherwise.
WHOPAYS	Who pays for electricity in building
YRBUILT	Year in which building was built

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VII. Methodology for Self-Report Analysis of NTG Ratio

A. Historical Basis of the Method

The first method of estimating the net-to-gross ratio is based on participants' self-reports of their selection processes and their likelihood of installing energy efficient equipment[1] had the rebate not been available. Many different self-report methods have been used to measure these processes, but the method used in the current report has been based on interview questions developed by Cambridge Systematics, Inc. (CSI), under subcontract to Xenergy, and described in a report entitled "Net-to-Gross Ratios for PG&E's CIA Rebate Program"[2]. That study tested twelve alternative methods of estimating net-to-gross ratios and compared their results. One method was selected by the authors from the alternatives studied as combining the best features of each method.

The procedure recommended by the CSI/Xenergy study uses customers' stated intentions about installations and the efficiency of the installed equipment as the core of the method. Then consistency checks are made using other questions about the customers' decision-making processes. Where there are inconsistent responses, the core information is modified to reflect the contradictory information. An example of such an inconsistency is a situation where the respondent says that the company almost certainly would not have installed the same equipment without the program, but also indicates that they learned about the program *after* installation. Another example is a respondent who says that they almost certainly would have installed the equipment even without the program, but then reports that the rebate was extremely significant in the decision to install. In each of these examples, the answer to one question implies a very high probability of extra-program installation, and the answer to the other question, within the same interview, implies a very low one. The system of checks developed by CSI/Xenergy insures that neither extreme will prevail in these situations.

Another problem ameliorated by the CSI/Xenergy method has been experienced by many investigators. This is the problem engendered by the practice of asking the respondent if the company would have installed the same equipment without the program, and ending the questioning at that point. This leaves ambiguity in the assessment of the customer's probability of free ridership because the respondent may interpret that question as asking if they would have installed an *air conditioner* regardless of the program; the answer, "yes I would have installed the same equipment" could be given even when the reality is that the air conditioner would have been much less efficient than the one purchased under the influence of the program. The method developed by CSI/Xenergy follows up this general question with another which specifically asks if the equipment would have been of the exact same efficiency. A further follow-up question asks if the equipment would have been installed at the same time or later than occurred within the program. This practice clears up another ambiguity which flows from asking a single question about whether the respondent would have installed the same equipment outside of the program. In other words, they may have installed the same efficiency level, but would have done it a year or two later than they did as program participants.

All of these improvements are valuable contributions to the self-report method of estimating free-ridership probabilities, and were adopted in the current study. However, further improvements were made for the evaluation of the 1994 Commercial HVAC Impact Evaluation. The CSI/Xenergy method asked the free-ridership questions in a Likert format, using as response categories such phrases as:

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[1] The telephone survey of participants only addressed the installation of energy efficient *electric* equipment.

[2] Report Number CIA-93-X01E, September 1993.

1. Definitely would NOT install anyway
2. Probably would NOT install anyway
3. Probably would install anyway
4. Definitely would install anyway

Analogous response categories were used for each of the free-ridership questions. This method produces the problem that there is no direct translation of these responses to a quantitative free-ridership probability that varies between 0 and 1, which could then be converted to a net-to-gross ratio (1 - free ridership). The CSI/Xenergy method addressed this problem by assigning net-to-gross probability values to the response categories in the following way:

1. Definitely would NOT install anyway	95%
2. Probably would NOT install anyway	70%
3. Probably would install anyway	5-60% depending on efficiency questions
4. Definitely would install anyway	5-60% depending on efficiency questions

In this system, participants who say they definitely or probably would not install the same equipment are assigned net-to-gross probabilities (95% and 70% respectively). However, the assignment of other (lower) probabilities for answers saying they probably or definitely would install anyway are modified according to answers to questions about equipment efficiency (5 - 60%). Further modifications were made based on respondents' answers to questions about the significance of the rebate and when in their search and purchase process customers heard about the program. This method of assignment has at least two drawbacks. First, the assignment of probabilities is necessarily arbitrary; there is no inherent probability associated with any one or combination of questions with this Likert-type format. Second, the use of discrete categories and the consequent discrete probability levels has a strong tendency to "clump" probability values and to move the final result toward the center of the 0 - 1 range.

The method developed for the current study addresses these problems. This is accomplished by asking the respondent to assign a probability directly to the company's likely actions absent the program. However, the respondents were not asked directly to provide a "probability"; instead, they were asked to rate, on a scale from 1 to 10, their chances of acting. This type of scale is relatively easy to translate into a probability. Further, it is a scale that is in common use in American culture and people are used to using it to rate people, events and things.

B. Detailed Description of Modified Method

The questions

During the pre-test of the participant interview instrument, respondents were asked the planned series of questions to assess the impact of the program on their installation decisions, i.e., the net-to-gross questions. It became clear during the pre-test that respondents were often confused by some of the questions, and were very frequently giving internally inconsistent answers. As a response to that problem, a new question was added, not intended for analysis, but to orient the respondent. This question was, "When and how did you first learn about PG&E's Energy Efficiency Program?" Not only did this help to orient customers to think about the sequential process of hearing about the program relative to their decision-making process, but it gave the interviewer a point of reference for judging the appropriateness of responses to subsequent questions. The addition of this orienting question improved the customers' responses noticeably and so was adopted into the final form of the interview.

Questions were asked in the following sequence:

1. Following the orienting question, participants were asked a series of questions to place the event of hearing about the PG&E program in the sequence of thinking about installing new equipment, collecting information, selecting the equipment, and installing it. This was a series of questions to which respondents answered that they heard before versus after each step.
2. The next question asked how significant the rebate was in the decision to install the equipment. This question was rated from 1 to 10, with 1 being not at all significant, and 10 being very significant. This question is often referred to as the "significance" question in the pages that follow.
3. The next question queried participants on how likely it was that they would have installed the same equipment if there had been no rebate available. Respondents were asked to rate this likelihood on the 1 to 10 scale, with 1 being not at all likely, and 10 being very likely. This is one of two questions referred to as "likelihood" questions, the next question being the other.
4. The next question was asked only of participants who had installed efficiency-rated equipment[3], including air conditioners and water chillers. These respondents were asked if they would have installed equipment of the same efficiency level as the equipment they installed through the program, if there had been no rebate available. This too was rated on the 1 to 10 scale, from not at all likely to very likely.
5. The final question in the net-to-gross series asked the customer, if the rebate had not been available, whether they would have installed the equipment (1) at the same time that they did under the program, (2) between six months to a year later, (3) over one year later, or (4) never.

The original (CSI/Xenergy) method took the combination of answers to two questions as the core responses: "How likely is it that they would install the same equipment without the rebate?" and, "How likely is it that the equipment would have been the same efficiency without the rebate?" to assign probabilities. Those probabilities would then be modified by answers to questions about when the participant heard about the program, and how significant the rebate was to their decisions.

The current study took the same questions as the core questions, but did not assign probabilities to combinations, as the probabilities were self assigned. Further, it was not practical to modify the core questions by the other questions in exactly the same way that was done in the original study. All of the options for overriding one probability response with another would be arbitrary, and this arbitrariness was what we were trying to get away from by having respondents assign their own probabilities. Thus, a modified approach was required. In general, a method of averaging responses was used. The exact methods used will be described later.

[3] Some equipment types, such as air conditioners and chillers, are energy efficient in varying degrees. These pieces of equipment are given efficiency ratings according to government standards. In general, the more efficient the particular model, the more expensive it will be. Other types of equipment, e.g., time clocks, window film, etc., are not efficiency rated because they don't vary in efficiency level. Throughout this document, equipment that varies in efficiency will be referred to as efficiency-rated equipment or rated equipment. Other types will be referred to as non-rated equipment.

C. Data Analysis

Preliminary Data Processing

As indicated in the previous section, probabilities were self-assigned by each of the 450 interviewed program participants, based on the questions concerning the likelihood that the customer would have installed the same equipment if the rebate had not been available and on the significance question. Then information on when the customer heard about the program, and when they would have installed the equipment without it was employed to increase the reliability of the measures. However, preliminary steps must be described before the combining method is explained. The preliminary steps were necessary because:

1. the likelihood of installation questions were stated in a direction that would yield the probability of free ridership rather than the complement to that, the net-to-gross ratio, and
2. the scale used in the questionnaire ranged between 1 and 10, not between 0 and 10 as would be appropriate for direct conversion to a probability, always stated between 0 and 1.

The core questions were asked in the direction they were for reasons of interview clarity. To ask the likelihood questions in the direction directly translatable to a net-to-gross probability would have required asking the questions in a negative way, raising the possibility of confusing respondents. It is simpler to recode a scale by machine to read in the opposite direction, than to interpret answers to confusing questions. This recoding was done on the questions that required it, i.e., only the likelihood questions.

If the scales had been instituted as a 0 to 10 range, the probability conversion would have been achieved simply by dividing the response by 10. The range actually used, 1 to 10, does not allow this method of conversion to probabilities. The range was given in this way because the scale in common use in American culture is the 1 to 10 scale, and it was the wish of the researchers to conform to these common understandings. The result, however, is that a slight modification must be made to the scale in addition to transposing it and dividing by 10 to convert it to a net-to-gross probability.

It would be possible, in some situations, to use the converted scale in a .1 to 1 form. This would not be appropriate, however, for the net-to-gross ratio. In this case, it is important to have a "0" point. It is clearly justifiable to consider responses of "1" equivalent to ""0", and this conversion was made. All other response levels were left as they were given by the respondent. This method leaves the response of "1" unused. The only other choices available were (1) to spread the 10 responses evenly between the 11 points in the 0 to 10 range, and (2) to choose some other probability level to remove. The first method is arbitrary and alters the entire scale as responded to by the customer. There is no reason to choose any other probability to move/remove than the one at the end of the scale. The lower end of both core questions contains the fewest responses; therefore limiting the alteration of the responses to that area changes the actual participant responses the least. This is an important feature since the point of asking the questions in this way and providing response possibilities in this way, was to allow customers to assign their own free-ridership/net-to-gross probabilities.

In practice, the scales for the two likelihood questions were altered in the following ways, in the following sequence:

1. Answers to both likelihood questions as given in the interview, were changed only if the response was "1" (i.e., very unlikely to have installed the same equipment without the rebate). These responses were changed to "0", leaving no cases occupying the value "1".

2. The scale was then reversed, recoding "0" responses to "10", "2" responses to "8", etc. (There were no "1" responses after executing step 1.)
3. After reversing scales so they could be interpreted in the same direction, i.e., a high score implies a high net-to-gross ratio, all 0 - 10 scores were divided by 10 to provide a score that could vary between "0" and "1", interpretable as a probability. This step was applied to the significance question as well as the likelihood questions.

Assigning a net-to-gross ratio value to each respondent

After transforming respondents' response scores to a form in which a high score always carries a meaning of high net-to-gross, and further transforming them to fall into a 0 - 1 range, the next step was to combine scores in a way that takes advantage of multiple pieces of information to improve overall reliability.

The first step in combining responses was to assign only one score on a likelihood of installation to each respondent. The likelihood of installing equipment without a rebate question was asked of all respondents. The likelihood of installing equipment with the same *efficiency* was asked only of the participants who installed rated equipment. However, the latter question was not simply a follow-up question to the more general one, it stands alone; and it is the more important and valid question for those who installed rated equipment. Thus, it was used as *the* likelihood question for rated equipment decisions, and the *general* likelihood of installing the same equipment was used as *the* likelihood question for those who installed unrated equipment such as window film, thermostats, energy management systems, etc.

The next step was to take an average of the likelihood question score and the "significance" score to form a core probability score. However, a careful analysis of all responses to these two questions revealed some inconsistencies between the two. An example of such an inconsistency is a respondent who indicated that the rebate was very significant in the decision to install the efficient equipment, but also said that they would have installed the same equipment without the rebate. A small sample of the most extreme cases of contradictions was interviewed a second time to clarify the issues. These interviews revealed that some respondents construed the significance question to mean something different than was asked. Sometimes this seemed to be due to a language problem. More often the customer indicated that, even though they would have installed the same equipment without the rebate, the rebate was large enough to be a "significant" financial boon and, therefore, they indicated to the interviewer that the rebate was "significant". This indicates that some portion of the respondents gave invalid answers. However, inspection of the joint distribution of both questions showed that most cases followed an expectable pattern of responses to the two questions. It was decided to remove the situations where there were obvious (i.e., extreme) cases of contradictory answers. This was done by eliminating cases from the averaging procedure when they fell into one of the two most extreme scores on one question and in one of the two most extreme scores on the contradictory end of the second question. For example, if the answer to the question, "...how significant was the PG&E rebate in your decision to install this equipment?" was "9" (high significance) and the answer to the question, "If the PG&E rebate had not been available, how likely is it you would have installed the same equipment....?", was also "9"[4] (high likelihood of installing without rebate), this would constitute an extreme case of contradictory answers. In such a case, the significance question was not used; only the likelihood question was used to form the core probability score. This choice was made because the evidence is that it is the significance question which is the more likely to be invalid. To summarize, the significance question and the likelihood question were averaged to

[4] The values are discussed in their original form here, not in their transformed state because the reference is to the questions as they were asked and answered. The principles remain the same regardless of the form of the values.

produce a core probability score unless the two questions yielded very contradictory answers. In these cases, only the likelihood question was used for the core probability score.

Two modifications were applied to the core probability score. First, if the respondent indicated that the company learned of the PG&E program after selection of the equipment, the core probability score was averaged with a probability of "0". Hearing about the program after selecting the equipment leaves little room for program influence, and this would imply a net-to-gross ratio of "0", or close to it. However, the information of the core probability score was also available. A choice presents itself at this point. The core probability score could be used, or a probability of "0" could be used reflecting the information about the timing of learning about the program. Since neither could be established as more likely valid than the other, the decision was made to average the two, thus giving equal weight to each response. Hearing about the program at any time prior to selecting equipment offers no evidence about the potential influence of the program. Therefore, these responses were ignored in favor of the core probability score.

Second, if the participant indicated that, without the program, the equipment would have been installed one or more years later than was actually done under the program, the net-to-gross probability was set to 1. The rationale for this decision is that, even if the participant would have installed exactly the same equipment without the rebate, if they had delayed the installation for a year, the first year savings would be attributable to the program, and this study, per the Protocols, addresses only first-year savings.

In summary, probabilities were assigned in this manner (See Figure VII-1):

1. For installers of non-rated equipment, the probability associated with the general question on the likelihood of installing the same equipment in the absence of the program was averaged with the question on the significance of the rebate in decision making to produce the core probability score. There were two exceptions:
    - If the company learned of the program after selecting the equipment, the response to the core net-to-gross question was averaged with 0.
    - If the company would have installed the equipment one year or more later than they did, the net-to-gross probability was set to 1.

1. For installers of rated equipment, the probability associated with the question on whether they would have installed equipment of the same efficiency in the absence of the program was averaged with the significance question, and this produced the core probability score, with the same exceptions listed above.

Assigning weights

The individual net-to-gross probabilities assigned to each of the 450 participants were subjected to two types of weights before taking the group mean. One type of weight that is appropriate is the normal case weights that reflect the probability of each location being selected into the sample. The calculation of these weights is described in Appendix H and that description will not be repeated here. It is only mentioned here to note that this analysis includes the same case weights used in other analyses.

The second form of weighting for the net-to-gross ratio was based on the first-year avoided energy and capacity costs associated with the savings generated at each site. Calculating avoided cost weights starts with the savings estimates provided by the program data base. These savings have been enhanced through engineering simulations as described in other parts of this report. Those enhanced savings were then allocated to costing periods using load profiles developed on the basis of on-site survey inspections and DOE-21E simulations. These allocations were considered superior to PG&E's H-factors for commercial savings, from PG&E's Annual Summary Report on Demand-Side Management Programs. This is because the PG&E H-factors reflect the entire commercial sector, whereas the load profiles estimated for this study are specific to HVAC equipment installed under the program being evaluated. The proportional allocations used are shown in Table VII-1.

Table VII-1: Costing Period Allocations

Costing Period	kWh	kW
Summer On Peak	.132	1.00
Summer Partial Peak	.132	.902
Summer Off Peak	.299	.532
Winter Partial Peak	.262	.515
Winter Off Peak	.175	.430

Marginal energy and capacity costs were applied to the appropriate savings by costing period. Appropriate marginal costs were obtained from Table TA-1.2 in PG&E's Annual Summary Report on Demand Side Management Programs in 1994 and 1995: Technical Appendix. This table specifies different costs for primary and secondary customers, primary customers being those who have a separate distribution station. Three customer types were identified among the 450 sample participants: primary, secondary, and transmission. Transmission customers were combined with the primary group. Table VII-2 shows the marginal energy costs, and Table VII-3 displays the marginal capacity costs.

Each costing period savings calculation was multiplied by the relevant energy and capacity costs to arrive at a total avoided costs figure for each respondent. This total was used as the weight for the net-to-gross probability derived from the participant's survey responses. The total of these weighted net-to-gross probabilities was then divided by the total avoided costs for the entire sample to arrive at a weighted average net-to-gross ratio.

Table VII-2: Marginal Energy Costs for Primary and Secondary Customers

Costing Period	Primary $/kWh	Secondary $/kWh
Summer On Peak	.04210	.04413
Summer Partial Peak	.03457	.03583
Summer Off Peak	.03170	.03266
Winter Partial Peak	.04642	.04868
Winter Off Peak	.03799	.03908

Table VII-3: Marginal Capacity Costs for Primary and Secondary Customers

Costing Period	Primary $/kW	Secondary $/kW
Summer On Peak	46.79	48.18
Summer Partial Peak	5.28	5.46
Summer Off Peak	19.58	20.23
Winter Partial Peak	21.60	22.30
Winter Off Peak	3.25	3.36

VIII. Methodology for Discrete Choice Analysis of NTG Ratio

Discrete choice analysis represents an alternative to more traditional methods of handling the self-selection bias observed in net estimation. For the commercial incentive programs, each customer has a choice among three options regarding an eligible measure: (1) implement the HVAC measure within the program, (2) implement the HVAC measure outside the program, or (3) do not implement the HVAC measure. The customer chooses the option that provides it with the greatest "utility." The utility that the customer obtains from each option depends on the investment cost, energy savings, and other factors associated with the option. Participants are customers who choose option 1, while non participants choose either option 2 or 3. To determine net savings, a discrete choice model is estimated that describes customers' choices among these options, using data on the actual choices that participants and non participants made during the program period.

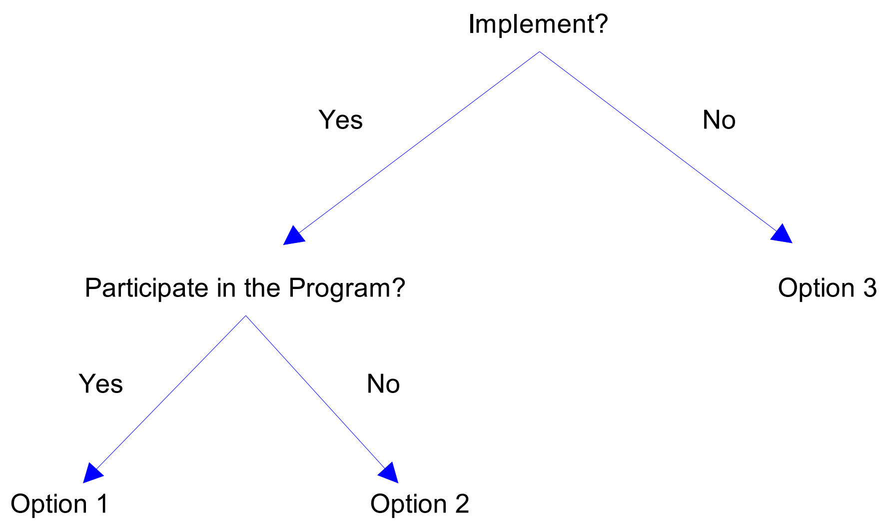
A. Nested Logit

Some factors that affect the utility of each option are observable (such as the installation cost and expected savings). However, other factors are not. For example, the non-monetary "hassle" of making changes, which cannot meaningfully be measured, might affect the utility to the customer of options 1 and 2. The customer's uncertainty about the cost and especially about the savings can also be expected to affect its utility from options 1 and 2, but are not generally observed. Some unobserved factors affect the utility of option 1 that do not affect option 2, such as the hassle of applying for a rebate or the cost and difficulty of documenting the installation and its cost (which is usually needed to receive a rebate). In fact, it is because of these factors that a customer might choose option 2 over option 1 (i.e., implement the measure but not apply for a rebate).

If the unobserved factors were independent over options, then a standard logit model could describe the probabilities. However the unobserved factors are clearly not independent: unobserved factors relating to the installation of the measure enter the utility for both options 1 and 2, since both of these options entail implementing the measure. One model is required that recognizes the correlation between unobserved factors. Assuming that the errors are not correlated (as for a simple logit model) is equivalent to assuming that the implementation rate among customers who did not receive a rebate (i.e., who chose options 2 or 3) is the implementation rate that rebated customers (i.e., customers who chose option 1) would have had in the absence of rebates. This is essentially the same as saying that participants would have behaved like non participants if the program had not existed, which Train (1994) indicates is an inappropriate assumption for net savings analysis.

Nested logit explicitly recognizes the correlation in unobserved factors over options. With nested logit, the two similar options—in this case options 1 (implement the measure within the program), and 2 (implement the measure outside the program)—are nested together. Thus, Figure 1 illustrates the model structure that consists of two parts: (1) a "top" model of customer's choice of whether to implement the measure, and (2) a "bottom" model of whether the customer participates in the program given that the customer implements the measure. We plan to estimate the nested logit model sequentially using SST. Finally, through a series of simulations using the estimated models, both the gross impacts and the net impacts are estimated. The ratio of these two is the net-to-gross ratio. The following sections describe this approach in detail.

Figure VIII-1: Customer Decision Options



Step One

First, we estimated a logit model for the customer's decision to participate in PG&E's commercial Retrofit Program. Since implementation is a precondition to participation, the participation model was estimated only on those customers who implemented an HVAC measure. Since the customer decides whether to participate in the program, this is a discrete choice (yes or no) and can be represented by a logit model that takes the form:

$$P_{P_i} = \exp^{(\beta Z_i)} \div (1+\exp^{(\beta Z_i)}) \quad (1)$$

where P_{P_i} is the probability of participating (choosing option 1 over option 2) in the commercial retrofit programs for the i^{th} customer; Z_i is the vector of explanatory variables corresponding to the i^{th} customer that affect the outcome of the choice; and β is the vector of estimated coefficients that maximizes P_{P_i}.

The variables included in vector Z are both premise characteristics and macroeconomic factors experienced by the customers that affected their decisions to participate. For example, these variables might include the size of the customer's facility, the pre-program average monthly electricity usage, the pre-program average monthly cooling degree days, the rate class, the building type, or employment in the commercial sector. The probability of participation will be estimated for each of those customers who implemented efficient equipment using the actual choice made by the customer, whether they received a rebate or not.

Using the estimated parameters on the set of Z variables, a Log Sum variable was then calculated:

$$LS_i = \log(1+e^{\beta X_i}) \quad (2)$$

The Log Sum variable reflects the similarity (or dissimilarity) between options 1 and 2 as viewed by the customers. The way in which the implementors (all customers included in the participation model) view options 1 and 2 affects their decision to implement. Thus, the Log Sum variable was then included as one of the explanatory variables in the implementation model.

Step Two

Next, a discrete choice model was formulated to capture the customer's decision to implement a conservation measure:

$$P_{Ii} = \exp^{(\alpha LS_i + \delta X_i)} \div (1+\exp^{(\alpha LS_i + \delta X_i)}) \qquad (3)$$

where

P_{Ii} = the probability of implementing a measure (choosing option 1 or 2 over option 3) for the i^{th} customer

X_i = the vector of explanatory variables corresponding to the i^{th} customer that affect the outcome of the choice

LS_i = a proxy that indicates the i^{th} customer's perception of the difference between options 1 and 2, using the participation model results

α, δ = the estimated coefficients that maximize P_{Ii}.

Once again, customers' actual implementation decisions were used as the values of the dependent variable to estimate the model. The pool of information for vector Z in the participation model and vector X in the implementation model will remain the same.

Step Three

Once the participation and implementation models (Eqs. 1 and 3) were estimated, the *gross* savings were first simulated. These equations are repeated here for convenience.

$$P_{Pi} = \exp^{(\beta Z_i)} \div (1+\exp^{(\beta Z_i)}) \qquad (4)$$

$$P_{Ii} = \exp^{(\alpha LS_i + \delta X_i)} \div (1+\exp^{(\alpha LS_i + \delta X_i)}) \qquad (5)$$

Using the results of Eqs. 4 and 5, the gross impact is calculated as the probability of implementation times the probability of participating if implementing. This joint probability is summed over all participating and non-participating customers.

Next, Eq. 5 was used to simulate the behavior of customers with the first option removed (that is, to "forecast" what customers would have done if they had not had the option of implementing the measure with an incentive.) This simulation indicates the extent to which customers would have implemented the measures without the program; the energy savings under this simulation are the estimate of *naturally occurring savings*. Next, Eq. 5 was used to simulate the behavior of customers *with all three options available* (with the program option and the incentive available). The net savings of the measure were then calculated as the difference between (1) the savings that occurred with the program (when all three options are available) and (2) the naturally occurring savings. Finally, the net-to-gross (NTG) ratio was calculated as the net impact divided by the gross impact.

While we estimated gross measure savings for participants only, estimates of gross measure savings for non participants who may have installed an efficient measure were not available. Thus, we assumed that the gross measure savings remain constant across all customers. The implication of this assumption is that program-specific NTG ratios will not be weighted by gross measure savings.

B. Calculation of Confidence Intervals

The 80% and 90% confidence intervals will be calculated for the NTG ratio. This will be done by taking the standard deviation of the log sum that is calculated using the results of the participation model and multiplying it by the appropriate critical values, 1.28 and 1.65 respectively. The model is then re-estimated with the results of these two multiplications added to the log sum variable which is used in th calculation of the NTG ratio. Thus, the NTG ratio will reflect uncertainty surrounding a key variable, the log sum.

C. Model Evaluation

Model evaluation used three criteria. The first was the familiar t-test used to test the value of a *single parameter* in the model. The second was the somewhat less familiar Likelihood Ratio Test (LRT) which was used to evaluate the *overall model*. This test uses the likelihood function L which is defined as:

$$L = \prod_n \prod_i P_{in}^{d_{in}}$$

where

$\prod_i P_{in}^{d_{in}}$ = the product of the probabilities over all alternatives *i* for a given customer *n*

L = is the product over *all n* customers

The log of this function is defined as:

$$LL = \log(L) = \sum_n \sum_i d_{in} \log P_{in}$$

where

L = likelihood function

d = dummy variable indicating the option chosen by a customer

If a model is perfect, the LL is 0 but in practice only approaches 0. Now two LLs are produced automatically with each model estimated in SST. The first is the LLR which is the LL for the *restricted* model which assumes that all parameters are 0. The second is the LLU which is the LL for the *unrestricted* model. Using these two pieces of information, the LRT is calculated as follows:

LRT = 2(LLU - LLR)

LRT is distributed as a chi-squared random variable with degrees of freedom equal to the number of restrictions in the hypothesis. Thus, if the unrestricted model produces a LL that is larger than the LL for the restricted model and this difference is statistically significant then one can conclude that the unrestricted model is superior and that the parameters are not 0. The LRT can also be used to test models to determine whether the addition of another variable to a model containing, for example, 5 variables, produces a statistically significant improvement in the overall model.

The final criteria is whether the results of each model and the NTG ratio that they combine to produce are plausible. Just because the statistics appear to be correct is no reason to accept a NTG ratio of 2.5 or -2.5.

D. Participant/Comparison Group Definition

Participant Group

A participant is defined as a PG&E customer who received a rebate in 1994 for installing HVAC equipment through PG&E's 1994 Retrofit Program. Note that a participant, as defined, could have installed the HVAC equipment in 1993 but been paid in 1994. 1994 participants could also have participated in the 1992 and 1993 Retrofit Program for both HVAC as well as other measures.

Comparison Group

A member of the comparison group is defined as a PG&E customer who did not receive a rebate in 1994 for installing HVAC equipment. However, they could have received a rebate in 1994 for installing measures within other end-use categories such as lighting and refrigeration. They could also have participated in the 1992 and 1993 Retrofit Program for both HVAC measures as well as other measures. Additionally, members of the comparison group are those who have cooling equipment (e.g., central AC or chillers) and who may have replaced their cooling equipment or added new cooling equipment in 1994 and/or who had the option of installing some other HVAC-related measures such as ASDs, EMSs, or reflective window film.

E. Data Collection for Efficient HVAC Equipment

With this discussion of nested logit serving as the background, we can now address the specific measures that will be addressed in this portion of the study. Recall that nested logit examines three types of measure-installation conditions: 1) install with a rebate, 2) install without a rebate, and 3) do not install. To perform such an analysis, one must have a sufficient number of instances of each installation condition *and* be able to determine the efficiency of the equipment of each installation.

Program measures can be broken down into two basic types: those that consume energy but do so efficiently (e.g., efficient central air conditioners) and those that consume little or no energy and reduce energy consumption (e.g., energy management systems and time clocks). For the former, a certain level of efficiency is required in order to qualify for a rebate. However, for the latter, there is no efficiency rating and thus no threshold required in order to qualify for a rebate. That is, simply to have installed an EMS will reduce consumption and is therefore sufficient to qualify for a rebate.

Now for participants, we know what they installed including, where relevant, the equipment efficiency ratings. How difficult it is to obtain this information for non participants will depend on what was installed. First, we believe that obtaining non participant self reports for non energy using measures such as EMS and adjustable speed drives (ASD) was reasonably reliable, assuming respondents understood what an EMS and ASD are. To insure understanding, such measures as EMSs and ASDs were carefully defined in the telephone interview prior to asking these questions. Of the respondents, 25 indicated that they has installed such measures.

For other measures such as central air conditioners, we attempted to obtain the level of efficiency, e.g., SEER or EER. This required asking the telephoned non participants the manufacturer, model number, serial number, and other nameplate information in order to calculate the energy efficiency ratio (EER) and the seasonal energy efficiency ratio (SEER). Some respondents were able to provide this information during the first phone call. Others had to be given some time to collect this information and then called back to obtain it. Of the 32 non-participants who indicated that they installed cooling equipment in 1994, information sufficient to determine the efficiency rating of the equipment was obtained for only 19 installations. Of these, only three of these installations would have qualified for a rebate, representing two premises.

Dependent Variables

Of course, the dependent variable for the participation model was different than the dependent variable for the implementation model.

- The participation model was estimated using all participants and those non-participants who implemented one or more HVAC measures for which they *could have* received a rebate in 1994. Thus, a 1 was assigned to each of the 438 participant premises and a 0 was assigned to each of the 26 non-participant premises that installed a qualifying HVAC measure. Thus, the total n for the participation model was 464.

- If the implementation model was being estimated, then a 1 was assigned to those 438 participant premises that implemented an efficient HVAC measure for which a rebate was paid in 1994 and to the 26 non-participant premises that implemented an efficient HVAC measure in 1994 for which a rebate *could have* been paid. For those 416 non-participants who did not install a qualifying HVAC measure, a 0 was assigned. Thus, the total n for the implementation model was 880 (464 + 416).

Explanatory Variables

The vector of explanatory variables is comprised of several categories. These variables represent various activities in what we have termed the *pre* period[1]. For participants, this is the period before the equipment installation date, a variable constructed from various dates in the Program Database. For non-participants who installed qualified equipment in 1994 but without a PG&E rebate, this is the period before their self-reported installation. For non-participants who did not install qualified equipment in 1994, we chose June of 1994 as separating the pre- from the post-period, since that is the modal month of participant installations.

These explanatory variables fall into six groups:

1. Equipment installed *with* a rebate paid in 1992 and 1993
2. Equipment installed *without* a rebate paid in 1992 and 1993
3. Changes in business other than equipment installations
4. Weather information

[1] For a more complete discussion of the construction of the pre period, please see Section ???

5. Economic indicators
6. Business and building variables that did not change during the pre period

The treatment of each group will be discussed in the following sections.

Equipment installed *with* a rebate paid in 1992 and 1993 and *without* a rebate. Both participants and non-participants can and do install equipment outside of 1994 during the pre period and we can expect an effect on both implementation and participation. First, equipment installed under 1992 and 1993 rebate programs were identified through the MDSS database. Second, information on *non-rebated* installations spanning the pre-installation period was gathered during the telephone interview. Data collected during the telephone interview included the following:

Rated, Energy-Using HVAC Equipment

- Cooling equipment -- Replacements
- Cooling equipment -- Additions
- Heating equipment -- Replacements
- Heating equipment -- Additions

Unrated, Non-Energy-Using Technologies

- Adjustable speed drive -- Additions
- Energy Management Systems -- Additions
- Time Clock -- Additions
- Setback Thermostat -- Additions
- Reflective Window Film

Lighting Equipment

- Lighting fixtures -- Replacements
- Lamps -- Replacements
- Lamp removals

For each of these equipment items, the month and year of installation during the period 1/92 through the date of the interview was elicited from the respondent. This was important because the time of installation was used to sum information on these variables prior to the estimated installation date.

Changes in businesses other than equipment installations. Another type of change in the pre period, unrelated to the program, but that can also affect both participation and implementation are changes in floor area (increases or decreases in square feet) and changes in business hours (increases or decreases in number of business hours). Both changes in square footage and business hours were measured by asking the respondent to report any changes in square footage since 1992. Any changes during the pre period were used as an explanatory variable. The same was true of business hours. The reported changes in these variables were summed for the pre-installation period.

Weather Information. The mean monthly cooling degree days for the pre period were calculated using temperature information for the 25 PG&E weather stations. Cooling degree day set points were used according to the table in Appendix C which were specific to building type and reflect engineering data and observation. However, the file also contained set points five degrees above the standard for the building type and five degrees below so that the effect of other set points might be explored if necessary. Heating degree day set points were not available for specific building types. Therefore, a constant set point of 60 degrees was used. The average monthly CDD and HDD were calculated for the pre-installation period.

Economic Indicators. Several macro-economic indicators were acquired for the purpose of accounting for the separate effect of prevailing economic conditions on customer decisions to participate and/or to implement HVAC measures. First, commercial employment figures were obtained in a quarterly format; they were provided in three sectors: (1) finance, insurance and real estate, (2) services, and (3) trade. The three employment areas were partitioned into 12 months for each evaluation year, beginning with 1992, and they were summed across the three to form one total measure of employment. The information was provided by Metropolitan Statistical Area (MSA), and the appropriate employment figures were assigned to each sample premise based on its MSA. The mean pre period commercial employment was then used in our participation and implementation models.

A second economic indicator that was collected was quarterly taxable sales. These quarterly figures, too, were divided into three equal parts to conform to a monthly frequency. Again, the mean pre period taxable sales by MSA was calculated and used in our models.

A third indicator is the real per capita income, provided quarterly by MSA. It was prepared in the same way that the prior two indicators were. In addition to this variable, the California Consumer Price Index was provided. It is in quarterly units, but is not separated by MSA; it is a statewide variable. Therefore, the CPI does not vary by the geographic location of the sample businesses. In every other respect, however, it was prepared for the analysis file in the manner described above.

Another indicator of customer reactions to economic conditions as well as to social/political and weather conditions was developed specifically for this project. It was reasoned that electricity consumption over all customers would vary with economic and other historical conditions. During recessions, consumption will decrease, and when business is good, electricity use will increase. However, both economic conditions and consumption will vary by business type and climate. Based on this reasoning, individual commercial sector consumption was aggregated by SIC to conform to the CEC-based categories of building type. In addition, aggregation included CEC climate zones so that each kWh value represents the combination of a two-digit SIC category and a climate zone. Therefore, a value appropriate to each sample member's business type and climate zone was assigned. This information is, of course, available in a monthly format, on a per premise basis. In summary, the mean pre period kWh consumption was included in the models to explain the effect of a variety of economic/weather factors on customer decisions.

Building and business variables that did not change. A number of key variables were included in the analysis that were expected to assist in discriminating between participants and non-participants and between implementors and non-implementors. Included are:

1. CEC-defined building types,
2. current conditioned square footage
3. whether the occupant owns or leases the business space

4. whether the occupant pays for their own electricity
5. whether their place of business is separately metered
6. who manages the building
7. the portion of the building occupied
8. approximate year in which the building was constructed.

F. Pre and Post Definitions

For the discrete choice analysis, we needed data for only the period *prior* to the decision to implement. In utility evaluations, it is usually quite challenging to operationalize, particularly for program participants, the pre and post installation periods[2]. In the program database, there are a number of dates associated with a number of events in any given installation's history. However, there is a fair amount of uncertainty surrounding the extent to which these dates accurately reflect the dates of the actual installations. Table VIII-1 below presents the keys dates that were used to estimate the installation dates and a brief description of each. The authorization date is the date on which the payment of the rebate is authorized. Thus, as a general rule, the installation of the equipment occurred before the authorization date. There are certain cases in which this date may not be the most accurate. These cases may involve more complex installations and thus require additional on-site inspections. These cases have one or more additional dates, the project completion date and the paid completion date. As one can see from the third column of Table VIII-1, the paid completion date was present for 8% of the installations.

Table VIII-1: Key Dates in Program Database

Date	Description	Participant Installations Having Date
Paid Completion	The date on which the rebate was paid	8%
Project Completion	The date on which the project was completed	10%
Authorization	The date on which PG&E authorized the installation of the equipment	100%

The project completion date was present for an additional 2% of the installations. Finally, the authorization date was always present. Thus, the third column of Table VIII-1 also represents the percent of the installations in our participant sample that were assigned each of these three dates as the installation date. For the 8% of the customers with a paid completion date, we used that date as the best indicator of the date of installation. For the 2% who did note have a paid completion date but who did have a project completion date, we used that date as the best indicator of the date of installation. For the remaining 90%, we used the authorization date as the best indicator of the installation date.

[2] For non participants, we were forced to rely solely on self reports regarding what may have been installed and the date(s) of installations.

For non-participant installers, we used the self-reported date of installation as defining the beginning of the post period. For non-participant non-installers, we defined the pre-period as prior to June, 1994 since this was the median date of installation for participant and non-participant installers.

G. Data Dictionary

Following is a description of the variables that are used in the discrete-choice analysis of net-to-gross ratio.

Variable Name	**Variable Description**
DEPVAR	Coded 1 if efficient HVAC equipment added with a rebate paid in 1994 (for participants) or outside the program in 1994 (for non participants).
HOSPCLIN	Coded 1 if premise is a hospital or clinic, 0 otherwise.
COMSERV	Coded 1 if premise is commercial services, 0 otherwise.
PREAGG	Pre installation monthly mean kWh of 228,000 premises divided into 2-digit SIC and CEC climate zone groups, with appropriate value assigned to each sample premise.
PRECDD	Pre installation monthly mean of cooling degree days for closest weather station for each sample premise.
PRECPI	Pre installation mean statewide Consumer Price Index.
PRETOTEM	Pre installation monthly mean commercial employment by MSA.
PREHDD	Pre installation monthly mean of heating of degree days for closest weather station for each sample premise.
KWHPRE	Pre installation mean monthly kWh.
SKWHDELT	Pre/post installation difference in mean monthly kWh. Pre/post difference taken by subtracting post from pre kWh mean.
DIFPROP	Pre/post installation difference in monthly kWh as a proportion of the pre-installation kWh. Pre/post difference taken by subtracting post from pre.

FOOD	Coded 1 if premise is a food store and 0 otherwise.
HOTMOTEL	Coded 1 if premise is a hotel or motel 0 otherwise.
PART3	Coded 1 for participants, all of whom received a rebate for installing efficient, and for non-participants who installed equipment that could have qualified for a rebate in 1994, 0 otherwise
COOLSQ	Conditioned square footage.
OFFICE	Coded 1 if premise is a large or small office, 0 otherwise.
PART2	Coded 1 if received a rebate in 1994 for installing HVAC equipment, 0 otherwise
MISC	Coded 1 if premise is a personal repair business or miscellaneous, 0 otherwise.
RESTAU	Coded 1 if premise is a restaurant, 0 otherwise.
RETAIL	Coded 1 if premise is a large or small retail store, 0 otherwise.
SCHOOL	Coded 1 if premise is a school (primary, secondary school, college), 0 otherwise.
TENURE	Own or lease place of business
SEPMET2	Business separately metered
BLDGOCC	Portion of building occupied
MNGBLDG	A dummy variable indicating whether the respondent's company manages the building
LOCHGHRS	Number of business hours increased or decreased in the pre-installation period, multiplied by fraction of time affecting the customer decision.
LOCHGSQF	Number of increases or decreases in conditional square footage in the pre-installation period.
WEEKHRS	Weekly business hours
AUDIT	Number of audits received in pre-installation period
RESPPAYS	Who pays for electricity in building
HVACOP	Operation of HVAC system in non-business hours
LITOP	Operation of lights in non-business hours
PREYNPR	Monthly real per-capita personal income (1987$)
PRESLTR	Monthly retail sales in the pre period

LOACOOLE	Addition of qualifying efficient cooling equipment in the pre period period for which a rebate was not received
LOACOOL	Addition of qualifying cooling equipment in the pre period for which a rebate was not received
LOADDHTG	Addition of qualifying heating equipment in the pre period period for which a rebate was not received
LOASD	Addition of adjustable speed drive in the pre period period for which a rebate was not received
LOEMS	Addition of energy management system in the pre period period for which a rebate was not received
LOFIXREP	Replacement of lighting fixtures in the pre period period for which a rebate was not received
LOLAMPRP	Replacement of lamps in the pre period period for which a rebate was not received
LORCOOL	Replacement of cooling equipment in the pre period period for which a rebate was not received
LORCOOLE	Replacement of efficient cooling equipment in the pre period period for which a rebate was not received
LOREMLI	Removal of lights in the pre period
LOTIM	Addition of a time clock in the pre period period for which a rebate was not received
LOOT	Addition of other qualifying equipment in the pre period for which a rebate was not received
SKWHPRE	Mean monthly kWh consumption in the 12 months in the pre period
GLASPCT2	Percent of the walls that is glass
LOHN	A counter of non-energy using HVAC equipment installed with a PG&E paid in 1992 and 1993
LOHU	A counter of non-energy using HVAC equipment installed with a PG&E paid in 1992 and 1993
LOLU	A counter of energy using lighting equipment installed with a PG&E paid in 1992 and 1993
LOLN	A counter of non-energy using lighting equipment installed with a PG&E paid in 1992 and 1993
INPROG	All equipment in all end uses installed with a rebate in 1992 or 1993 in the pre period

OUTPROG	All equipment in the HVAC and lighting end uses installed outside the program in the pre period
PREEFIR	Mean monthly employment in finance in the pre period
RREESV	Mean monthly employment in services in the pre period
PREET	Mean monthly employment in trade in the pre period
PARTFNL	Dummy variable indicating whether a premise is a participant or non-participant
OWN	A dummy variable indicating whether the respondent owned their building or not
WARE	Coded 1 if premise is a refrigerated or non-refrigerated warehouse, 0 otherwise.

IX. Methodology for Billing Regression Analysis of NTG Ratio

A. Introduction

The objective of this analysis was to isolate the net program impact on kWh consumption through the use of regression analysis on a sample of participants and a comparison group of non-participants. Within this framework many choices are available. One choice that was made early in the process concerned the type of regression model to use, and the choice was made to use a change model. That is, the dependent variable in the model would be the change in kWh consumption between the period before program-related installations and the period after. There were at least two reasons for this choice. First, by building an analysis on explaining change rather than consumption, the potential problem of selectivity bias is reduced (although not eliminated). This is because there is less potential for participation propensity to be correlated with consumption *change* than with consumption *level* (Violette, 1991). Another reason is that a model that does not use a consumption month as an observation is not at risk for autocorrelation problems. The straightforward approach of a cross-sectional model focusing directly on the real variable of interest, i.e., change in consumption, was considered most appropriate.

One of the consequences of this choice is that most of the variables used to predict the change will, themselves be change-related. For instance, the *change* in equipment stock is more important than the *saturation* of equipment stock. This does not mean that no non-changing variables should ever be used. Sometimes non-changing variables such as building type can be related to the potential for change that exists. In addition, the building type designation can capture economic trends occurring differentially in different segments of the economy in ways that we could not otherwise measure. Therefore, the unchanging variable may be included. However, the criterion for judging each potential variable in this type of model must be whether or not the variable may predict *change*, not consumption.

A second choice that was made early is to estimate two separate models. This is because there are two basic categories of equipment that can be added or replaced. One category is that of energy-using equipment, and the second is non-energy-using equipment such as timeclocks, EMSs and thermostats, that use little or no energy, have no efficiency rating, and inherently conserve energy to the extent that they are used properly. As discussed in the next section, different comparison groups are required for these two types of equipment. Different sample compositions require different model estimations.

One of the difficulties of the comparison group method of estimating net effects in utility programs is that the participants are always self selected into the program, which means that non-participants have *not* self-selected into the comparison group. To the extent that the differences between the two groups can be observed, variables that represent those differences can be addressed by entering them into the model. The most difficult issue to address is the differences between participants and non-participants that are unobserved and unobservable. In this study, we address this using a method proposed and demonstrated by Train (1993) and by Goldberg and Train (1995), the use of inverse Mills ratios to adjust for selectivity biases. Traditionally, one Mills ratio was used, but in recent developments a strong argument has been made for the inclusion of two. This issue and those introduced above will be discussed in more detail in forthcoming sections.

One more issue should be mentioned here. Attrition always occurs in evaluation samples. The major sources of attrition in this study were interview refusals, and a lack of continuous billing history. Attrition can cause biases in the sample and it is therefore important to do extensive analyses on those potential biases. These analyses showed no serious biases occurred as a result of attrition. The full analysis is reported in Appendix D.

An integral part of regression analysis of net impacts is the inclusion of a non-participant group. A full description of the rationales for the use and definition of the participant and non-participant groups are provided in the next section.

B. Participant/Comparison Group Definition

Background

One of the methods for estimating the net impact of the HVAC measures offered through PG&E's retrofit programs involves the use of a comparison group, the composition of which obviously plays a critical role in estimating net impacts. Moreover, the composition of the comparison group depends on what type of technology is installed by participants. That this is the case begins with the basic understanding that equipment installations fall into two broad technology categories. The first category will be referred to as energy-using equipment, and includes such technologies as air conditioners, chillers, evaporative coolers, cooling towers, pre-coolers, and HVAC motors. These technologies, in addition to providing cooling through the use of energy, vary in the efficiency with which they operate. Further, these technologies are generally assigned efficiency ratings, such as Energy Efficiency Ratings (EERs), Seasonal Energy Efficiency Ratings (SEERs), Coefficients of Performance (COPs), etc. Finally, while some of this equipment is not rated, each type can be ordered relative to its counterparts as to efficiency. For example, evaporative coolers are not generally rated for efficiency level but they are considered more energy efficient than a comparable air conditioner under the right climatic conditions. Therefore, they too can be placed on an energy-efficiency continuum. The important issue that distinguishes this technology group is that customers choose to install one item within this group and that item falls somewhere on the efficiency continuum.

The second technology category is composed of items that do not consume energy (or consume a trivial amount), but inherently conserve it. They will be referred to as non-energy-using equipment (or technologies) and they include such things as ASDs, timeclocks, EMSs, setback thermostats, and reflective window film. Tables IX-1a,b provide a more detailed breakdown of these two technology groups and the measures codes in the MDSS program database which define each of these groups. However, the issue here is the implications of the group distinction for designing the appropriate comparison group.

Table IX-1a: MDSS Measure Codes for Energy Using Equipment

Measure Code	Technology
S1	Central AC
S2	Central AC
S3	Central AC
S4	Central AC
S15	Cooling Tower
S21	Evaporative Cooler
S12	Chiller
S13	Chiller
S10	Chiller
S11	Chiller
S9	Chiller

S6	Packaged AC
226	Evaporative Cooler
227	Pre-Cooler
239	Change/Add Other Equipment
240	Efficient HVAC Motor
243	Resize HVAC Motor
249	Efficient HVAC Motor
223	Change/Add Heat Pump
232	Add High Efficiency Chiller
234	HVAC System Conversion
241	HVAC efficient Motor
236	Gas Absorption AC

Table IX-1b: MDSS Measure Codes for Non-Energy Using Equipment

Measure Code	Technology
S20	Reflective Window Film
S22	ASD
S18	Setback Thermostat
S27	Economizer
S28	Clean Condenser Coil
S69	Clean Condenser Coil
S71	Insulation
248	ASD
204	EMS
201	Controls
202	Timeclock
212	Reset Controls
215	Economizer
271	Insulation
272	Reflective Window Film
299	HVAC Other
203	Time Clock- Electronic
207	Chiller Controls
228	Add Economizer
S17	Time Clock
S19	Timer
S29	Clean Condenser Coil
S7	Condenser: Remote Units

Participant Group

A participant is defined as a PG&E customer who received a rebate in 1994 for installing energy-using cooling equipment and non-energy-using technologies through PG&E's retrofit programs. Note that a participant, as defined, could have installed the equipment in 1993 and been paid in 1994. Participants who received rebates for HVAC measures in 1994 could also have received rebates for HVAC or other measures, such as lighting, in 1993 or 1995 or for other measures in 1994.

Comparison Groups for Billing Regression Analysis

At a general level, a non-participant is defined as a PG&E customer who has air conditioning and who may or may not have replaced or added HVAC equipment in 1994. They would certainly not have received a rebate in 1994 for HVAC equipment. A non-participant may have received rebates for HVAC equipment in other years, and could have received a rebate for lighting or other non-HVAC efficiency equipment in 1994**.** These previous and contemporaneous participants were allowed to enter the comparison group as probabilities allowed, because all commercial customers had the potential to participate in the retrofit program, including those who participated in the same program in prior years and those who received rebates for non-HVAC measures in 1994. The comparison group is meant to represent what customers would install if no rebates for HVAC equipment had been paid in 1994. The absence of rebate payments in 1994 would have found a customer population, some of which had participated in various programs in prior years. All of those customers could have made additional installations of HVAC equipment without program assistance; therefore, this type of customer should be allowed to enter the comparison group as the random process dictates.

More specific criteria for non-participant group selection were based on the type of equipment installed by the participant group to which the non-participants were to be compared. Following is a description and explanation of those criteria.

The appropriate comparison group for program participants who installed energy-using equipment would be a group of non-participants who also installed energy-using equipment. This way, if non-participants install equipment on a lower level of the efficiency continuum than participants do, this will be reflected in the relative kWh consumption of the two. Comparison of program installers of energy-using equipment with a general population that includes non-installers would be inappropriate. This is because a general population may include businesses with no space cooling equipment and, who would, therefore, have no opportunity to decrease consumption due to cooling equipment changes (This is a theoretical distinction as in this study customers with no air conditioning were screened out of the sample). ***The same is true for businesses that have cooling equipment but do not need to replace it***. If a business is not in the market for cooling equipment, there is no opportunity to purchase efficient equipment and consumption will not go down except for reasons unrelated to cooling equipment. The issue in determining the net effect of the program is to observe the effect of the rebate on the installation decisions of customers, and on the consumption sequelae. Non-participant installers have the opportunity to choose efficient or inefficient versions of this equipment category; thus, they serve as the appropriate point of comparison for program participants who have installed energy-using equipment.

It will be noted that this argument ignores the possibility of early replacement of cooling equipment. To the extent that non-participants could have replaced cooling equipment before burn-out, they could be counted as a point of comparison for the program participants. However, this would not be feasible to put into practice in a research design. To do so would require that nonparticipants be screened for the economic potential for early replacement. If they would benefit economically by an early replacement they would comprise a reasonable element in a comparison group. However, determining who would and would not find early replacement financially beneficial would be a nearly impossible task over the telephone, which was the method of choice for this study.

Non-energy-using technologies present different issues, and require a different type of comparison group. The appropriate comparison group for this type of installer is all customers who have current equipment and situations that make it feasible to install a non-energy-using technology. Ideally, one would have a comparison group for each technology type, and that comparison group would consist of customers who don't have that technology but have a situation that would make it feasible. Of course, it is not practical to assess the feasibility of each technology for each site in the potential comparison group. It was, therefore, necessary to assume feasibility for each. The main assumption underlying comparison group decisions in this area is that essentially all customers have the option of deciding to install one or more non-energy-using technologies. It is always possible to add window film (unless it is already installed), and having installed that, it is possible to install a setback thermostat. Even with those items in place it may well be feasible to install an EMS, and so on. Because of the nearly constant possibility of these types of installations, and because they do not vary in efficiency level, a general population of program non-participants are reasonable points of comparison. It could be argued that the ideal comparison group for these participants would be customers who had not installed any of these technologies over the past several years. However, screening for such customers is not practical. Of course it would cost a great deal to do it, but more than that, customers often do not know if such equipment has been installed over the years. This is especially true for EMS systems and HVAC motors. Therefore, the general population of non-participants may include some businesses that installed some non-energy-using equipment without rebates. This actually is not a problem since it represents customer behavior outside of the program. Of course, to the extent that such installations are spillover effects of prior program exposure or reflect market transformation, they contribute to unfair minimization of program effects. However, this cannot be avoided in this study.

On the other hand, it would be inappropriate to select a comparison group of non-participants to be non-energy-using equipment *installers* since there is no efficiency variation in these types of equipment. If you install the equipment, you get the fixed effect (fixed based on building, climate, and usage characteristics); therefore a program group consisting of non-energy-using equipment installers compared to a non-participant group of non-energy-using equipment installers would necessarily produce an apparent program effect of zero net savings.

Thus, for the regression net billing analysis, two separate net impact models were estimated. The first was designed to test the impact of the program on installation of energy-using technologies and their consumption effects. In this model, the comparison group consisted of non-participating customers who had cooling equipment and who installed some type of energy-using cooling technology. A second model was designed to estimate the program effects on non-energy-using installations and their consequent reductions in consumption. The comparison group in this analysis was a general group of non-participants. Note that it was possible for comparison group members to have installed one or more non-energy-using technologies at some time in the past. However, it was assumed that no one had installed *all* of these technologies and, therefore, were eligible to have installed one or more during 1994.

It should be noted that no provision was made in the Protocols for the differences in these two types of technologies or the consequences for analysis samples. Thus, a choice is faced. Strict compliance with the Protocols, ignoring this distinction, or breaking the required sample into two parts to account for the different types of equipment, but increasing the variance around the estimates that are made for the two samples. In this case we have elected to make separate estimates, but large variances can be expected.

C. The Regression Model

The change-based regression model that was employed has the following general form:

$$\Delta \text{kWh}_i = \alpha + \delta_1 \text{Part}_{i,e} + \delta_2 \text{Mills}_i + \delta_3 \text{Mills}_i * \text{Part}_{i,e} + \sum \delta_k \Delta \text{x}_i + \varepsilon_i \quad (4)$$

where

ΔkWh_i = change in kWh consumption from before the program to after the program for the i^{th} customer

α = a constant that captures the energy consumed through a set of unspecified equipment

δ_1 = a coefficient that reflects the energy change associated with participants who installed the e^{th} end use

$Part_{i,e}$ = a binary indicator for the ith participant installing the e^{th} end use

δ_2 = a coefficient that reflects the energy change associated with the selectivity correction factor

δ_3 = a coefficient that reflects the energy change associated with the selectivity correction factor for participants only who installed e^{th} end use

$Mills_i$ = the selectivity correction factor for the i^{th} customer

$Part_{i,e}*Mills_i$ = an interaction term that captures self-selection for participants only who install the e^{th} end use.

δ_k = a vector of k coefficients that reflect the energy change associated with a one-unit change in the k^{th} explanatory variable

ΔX_i = a vector of other explanatory variables, such as changes in square feet, operating hours, equipment stock, and the rate of inflation from before the program to after the program for the i^{th} customer

ε_i = the differences in energy consumption that are not explained by the model.

The following six sections elaborate the various aspects of this model and how it was applied. The first issue addressed in detail is the variable that reflects participation status, whose coefficient includes the net effect of the program.

Participation Variable

The participation variable is coded 1 if the premise received a rebate in 1994 for the installation of energy-efficient HVAC equipment. The variable is coded 0 if the premise did not receive a rebate in 1994 for energy-efficient HVAC equipment. As described earlier, the non-participant sample was allowed to contain premises that received rebates in other years for HVAC equipment, and was allowed to contain customers who received rebates in 1994 for non-HVAC equipment. This was true for both models estimated. However, as described previously, the composition of the non-participant group was different for the two models.

It was determined that there were 58 cases where both types of installations occurred, i.e., energy-using and non-energy-using. A decision was required on how to handle these 58 cases. They could have been included in the energy-using model or the non-energy-using model, but not both. If they were included in both analyses, their savings would be double counted. Based on prior knowledge that the investigators had of the tracking system estimates of savings for the two equipment groups, the decision was made to include them in the non-energy-using group. This was based on the fact that larger savings were expected from that group. If the double-installing group were included in the energy-using model their savings would likely overpower the smaller effects that might be detected for the energy-using equipment only sites. This problem would be exacerbated by the double installation. Thus, the cases were analyzed with the non-energy-using equipment installations.

Change in kWh Consumption

For participants, the dependent variable is the difference between the customer's energy consumption before installation of energy-efficient equipment versus after installation. In practice this was operationalized as taking differences between paired comparable months, and taking a mean of those differences. Thus, where appropriate, March, 1994 consumption was subtracted from March, 1993, April, 1994 from April, 1993, etc. A problem with this method is that, the only way to have a pre-installation period of 12 consecutive months (as required by the Protocols) is to include the installation month in either the pre period or the post period. We elected to include it in the post period. To the extent that all installations were not completed on the first or the last day of the installation month, counting the installation month in either the pre or the post period will have the effect of reducing the observed delta. For instance, if customers who installed in January, 1994, did so on January 31, the month of January would constitute a pre-installation month of consumption. However, to the extent that the installations occur earlier in January, the mean kWh consumption for the pre period would look lower than it should (because it includes some days of low consumption), and this would result in a delta that was biased downward. The opposite situation has the same result: if the installation month (e.g. January) is counted as a post period month, and the actual installation took place late in January the post period will appear higher than it should because it contains some days of high consumption. This also has the effect of reducing the observed delta, thus making the net effects appear to be smaller than they actually are.

For the non-participants that form the comparison group for non-energy-using equipment installers, some have installed equipment and some have not. For those who have installed equipment, the pivot month was based on the month the respondent reported as the installation month. However, many of the comparison group did not install equipment, so there was no pivot point. For this group it was defined as the median month of installation among the *participants*: June of 1994.

It should be noted that, consistent with the Protocols, the cut-off date for post-period consumption data was September 30, 1995. This means that customers who installed during the October through December period will not have 12 months of post-installation data. Those installing in December will have only nine months of post-installation kWh data. This did not result in losing those cases, nor in comparing pre- and post-installation periods covering different seasons however. The method of subtracting comparable months and taking a mean of the comparable months results in the December installers contributing to the model for their nine months of post-installation data paired with the comparable nine months in the pre-installation period. In all cases, the pre/post comparison is based on comparable months.

One approach to accommodating the ambiguity regarding installation date is deadbanding. The common practice of deadbanding the entire year of the program was not feasible in this case, partially due to the fact that a substantial number of installations occurred in 1993, not 1994. As indicated above, the decision was made to consider the installation month in the post period. This was not an unreasonable decision given that the dates available most consistently were the authorization date for printing a rebate check. In most cases, this would imply that the actual installation had occurred prior to the available date. It was on this basis that the installation month was counted as a post-installation month. Beyond that, however, the decision was made to conduct a sensitivity analysis that deadbands the installation month and the month before to test for the effects of the chosen pivot date. This was conducted as a sensitivity analysis and not considered for the final analysis because this practice results in fewer than 12 consecutive pre-installation months, thus putting the study outside of compliance with the Protocols. The results of the sensitivity analysis will be reported in the Results section.

Explanatory Variables

The vector of explanatory variables is described by six categories:

1. Equipment installed through the 1994 HVAC program
2. Equipment installed outside of the 1994 HVAC program (1992 through 1995)
3. Changes in business other than equipment installations
4. Weather information
5. Economic indicators
6. Business and building variables that did not change

The treatment of each group will be discussed in the following sections.

Equipment installed through the program. Equipment installed through the 1994 program is represented in the model in two ways. First, the installation of program-rebated equipment is represented in the model through the participation variable. Second, the type of equipment installed is represented by inclusion in one of the two models: one model for energy-using HVAC equipment and one for non-energy-using HVAC equipment.

Equipment installed outside of the program. Both participants and non-participants can and do install equipment outside of the program (before, during and after the program period, some rebated some not), and we can expect an effect on kWh consumption to result. Depending on when the installation is relative to the pivot point it could accentuate the program-related reduction or it could diminish it. Therefore, it becomes important to model the effects of these installations. Information for this purpose was collected in two ways. First, equipment installed under 1992, 1993 and 1995 rebate programs were identified through the MDSS database. Second, information on non-rebated installations spanning the 1992-1995 time period was gathered during the telephone interview. Data collected during the telephone interview included the following:

Rated, Energy-Using HVAC Equipment

- Cooling equipment -- Replacements
- Cooling equipment -- Additions
- Heating equipment -- Replacements
- Heating equipment -- Additions

Unrated, Non-Energy-Using Technologies

- Adjustable speed drive -- Additions
- Energy Management Systems -- Additions
- Time Clock -- Additions
- Setback Thermostat -- Additions

Lighting Equipment

- Lighting fixtures -- Replacements
- Lamps -- Replacements
- Lamp removals

For each of these equipment items, the month and year of installation was elicited from the respondent. This was important because the time of installation is heavily related to the effect it will have on the difference in consumption measured by subtracting post program consumption from pre program consumption. For example, if an EMS was installed outside the program at the same time that the rebated equipment was installed, the EMS installation would make the delta appear larger than it would have if only the rebated equipment was installed; if, on the other hand, it was installed at the beginning of the pre-rebated equipment consumption period (perhaps January, 1993), it would have no effect on the delta because the effect of the EMS would be constant from the beginning of the evaluation period until the end. Similarly, if the extra-program installation of the EMS occurred at the end of the evaluation period (e.g., September, 1995), it would be virtually unseen by the pre/post subtraction. However, if the EMS were installed at the two-thirds point of the pre period (e.g., in month eight of the 12-month pre period), the eight months before the EMS was installed would have the effect of making the pre period mean look larger than it would if the EMS had been installed before the measurement period or even at month one of the pre period. Thus, the shorter the pre period affected by the extra-program EMS, the larger the delta will look.

On the other hand, extra-program installations occurring early in the *post*-program installation period will cause the delta to look larger than it would if only the program equipment had been installed. Extra-program installations that occur late in the post period will have only a small effect on the observed delta. Thus, the earlier in the post period the installation occurred, the larger the delta will be.

Because of this pattern of potential effects, it was considered important by the investigators to take the date of extra-program installations into account in modeling the change in consumption over time. This was accomplished by using the installation date to calculate the fraction of each time period that would have an effect on the observed delta. More specifically, the fractions were calculated differently for the two periods as follows:

1. Fractions for installations occurring during the pre period were calculated by determining the proportion of the pre period that was covered by the use of the EMS. Then, this fraction is subtracted from one. The resulting fraction represents the size of the effect on the observed delta. In other words, the closer the installation is to the pivot point, the larger the effect on the observed delta and the larger the calculated fraction.

2. Fractions for installations occurring during the post period were calculated by determining the proportion of the post period that was covered by the use of the EMS. The larger the affected period, the closer the installation was to the pivot date, and the more the delta is affected, i.e., the larger the observed delta.

Calculating the fraction variable in this way results in the ability to say that the larger the fraction the larger the expected delta increase. The fraction variable was employed by multiplying it by the variable associated with the equipment. That variable was a dummy variable in the case of equipment installations.

Both pre and post period fractions were calculated to have the same relation with the delta; therefore, the two fractions could be combined into one variable which would be expected to have a positive coefficient in a model predicting pre minus post kWh consumption. However, the modeling will begin by considering the two fractions (multiplied by their respective variables) separately.

Calculations of fractions pertaining to equipment additions (as opposed to replacements) were handled the same way. However, in their cases, the signs of their coefficients should turn out to be opposite from those associated with replacement equipment.

Changes in businesses other than equipment installations. Another type of change, unrelated to the program, but that can affect the observed changes in consumption over time, are changes in floor area (increases or decreases in square feet) and changes in business hours (increases or decreases in number of business hours).

Both changes in square footage and business hours were measured by asking the respondent to indicate what the square footage was before and after the change. The same was true of business hours. The differences were calculated to use in this analysis. More specifically, business hours were measured by asking the respondent what the business hours were each of the seven days of the week, and holidays. These responses were converted into number of business hours per week. When there was a change in hours, this was determined by subtracting the new hours from the old. These differences, of course, were multiplied by their associated fractions that represent the time period that the change was in effect.

Weather information. Cooling degree day set points were used, as specified in Appendix C, which were specific to building type and reflect engineering data and observation. However, the file also contained set points five degrees above the standard for the building type and five degrees below so that the effect of other set points might be explored if necessary.

Heating degree day set points were not available for specific building types. Therefore, a constant set point of 60 degrees was used.

Economic indicators: capturing trend effects. Several macro-economic indicators were acquired for the purpose of accounting for the separate effect of prevailing economic conditions on consumption. First, commercial employment figures were obtained in a quarterly format; they were provided in three sectors: (1) finance, insurance and real estate, (2) services, and (3) trade. The three employment areas were partitioned into 12 months for each evaluation year, beginning with 1992, and they were summed across the three to form one total measure of employment. The information was provided by Metropolitan Statistical Area (MSA), and the appropriate employment figures were assigned to each sample premise based on its MSA. Since the model of which this variable will be part is a change model, the employment variable was differenced in the same way the consumption variable was: comparable months were subtracted, and a mean of the monthly differences was taken.

A second economic indicator that was collected was quarterly taxable sales. These quarterly figures, too, were divided into three equal parts to conform to the monthly approach of this model. Again, differences were taken across comparable months and pre and post installation period means of the differences were taken for use in the change model. These figures were also supplied by MSA.

A third indicator is the real per capita income, provided quarterly by MSA. It was prepared in the same way that the prior two indicators were. In addition to this variable, the California Consumer Price Index was provided. It is in quarterly units, but is not separated by MSA; it is a statewide variable. Therefore, the CPI does not vary by the geographic location of the sample businesses. In every other respect, however, it was prepared for the analysis file in the familiar manner.

Another indicator of customer reactions to economic conditions as well as to social/political and weather conditions was developed specifically for this project. It was reasoned that electricity consumption over all customers would vary with economic and other historical conditions. During recessions, consumption will decrease, and when business is good, electricity use will increase. However, both economic conditions and consumption will vary by business type and climate. Based on this reasoning, individual commercial sector consumption was aggregated by SIC to conform to the CEC-based categories of building type. In addition, aggregation included CEC climate zones so that each kWh value represents the combination of a two-digit SIC category and a climate zone. Therefore, a value appropriate to each sample member's business type and climate zone was assigned. This information is, of course, available in a monthly format, on a per premise basis. As with other indicators, comparable months were differenced and the mean difference was taken for the pre period as well as the post. In summary, this variable was included in the model to explain a variety of factors other than the central participation variable: economic, historical, social, weather, and others that are unknown to us, but that vary over time.

Building and business variables that did not change. Only one variable that was not change-based was included in the analysis: building type. This variable was included in the analysis in spite of the fact that it is not a change variable because it was considered a central descriptor that could affect the potential for consumption change and could be related to participation. It was not known if it would actually be predictive, but it was included because it was expected to capture economic activity levels that would be different in different segments of the economy. The original analysis file contained 16 CEC-defined building types. However, where there were fewer than 25 in a category, that category was included with another or was included in the miscellaneous group. Based on this criterion, large offices (N = 15) were combined with small offices, and large retail (N = 1) were combined with small retail. There were only 13 colleges. They could have been combined with primary and secondary schools but the decision was made not to do this as colleges are very different in equipment employed than schools. Since it could not stand alone, it was grouped with the miscellaneous category. Similarly, there were only four hospitals. The possibility of combining them with clinics was considered but abandoned for similar reasons applied to colleges; they were added to the miscellaneous group.

Consideration was given to translating the 16 building types to a series of 15 dummies and one omitted category. However, it was difficult to make a case for choosing an omitted category against which all others would be compared for effect. This situation could lead to confusion in interpreting building type coefficients if the meaning of the coefficient became important. Consequently, effect coding was chosen so that each building type coefficient could be compared against the group as a whole.

Mills Ratios

In earlier sections it has been acknowledged that selectivity biases are likely present in conservation programs and we have indicated that we will attempt to correct for them. Selectivity bias can be defined as the correlation of naturally-occurring savings with the decision to participate. In other words, customers who tend to conserve energy are also more likely to participate in conservation programs. Traditionally, this source of bias is corrected by inserting an inverse Mills ratio into the model. This method involves estimating net savings in three steps: (1) estimate a logit model for participation, i.e., find the determinants of participation in the program, (2) calculate an inverse Mills ratio from the probability of participation, and (3) estimate the regression model of consumption change integrating the inverse Mills ratio. Estimation of the logit model is described elsewhere in this report. Its result, however, was used here to calculate the inverse Mills ratio. For participants, it was calculated as:

$$\text{Mills} = -\left[\frac{(1-P)\times\ln(1-P)}{P} + \ln P\right]$$

For non-participants:

$$\text{Mills} = \frac{(P)\times\ln(P)}{1-P} + \ln(1-P)$$

where

P= the probability of participation.

This correction factor has traditionally been used to account for selectivity bias. However, it has been shown to correct only incompletely (Goldberg and Train, 1995). The commonly-used method addresses correlations of naturally occurring savings with the decision to participate. Further correction, however, is needed to deal with the correlation between *net* savings or net-to-gross ratio with participation. Net savings appear in the regression model in the participation coefficient; therefore, correction for the correlation between net savings and participation must appear in connection with participants only. This translates to interacting the same correction factor with the participation variable.

Variance calculations for savings estimates and net-to-gross ratios

The use of the Mills ratios in the estimation of savings adds a slight level of complexity to the calculation of confidence intervals, specifically in the area of the variance. Essentially, the variance of the participation dummy parameter and the participant Mills ratio must be pooled:

$$Var(\delta_1 + MM\delta_3) = Var(\delta_1) + MM^2 Var(\delta_3) + 2MMCov(\delta_1, \delta_3)$$

Where:

δ_1 = the coefficient for the Participation dummy

δ_3 = the coefficient for the Participation Mills variable

MM = the participant sample mean of the inverse Mills ratio

The net-to-gross ratio, using the double Mills ratio method is calculated as:

$$NTGR = \frac{\delta_1 + \delta_3(MM)}{G}$$

Where:

δ_1 = the coefficient for the Participation dummy

δ_3 = the coefficient for the Participation Mills variable

MM = the participant sample mean of the inverse Mills ratio

G = the estimate of gross savings

The variance of this net-to-gross ratio estimate can be expressed conceptually as:

$$\text{Variance of NTGR}=\frac{Var(net)}{gross^2}+\left(\frac{net}{gross^2}\right)^2 Var(gross)$$

Weighting the model

Below are described the methods used to develop the appropriate premise-level weights for both participants and non-participants.

Participant Weights. The participant weights are based on the item/domain sampling ratios. The calculation of the premise weights depends on the number of items installed at each premise. The specific procedure for calculating the premise-level weights used in this analysis can be found in Appendix H.

Non-Participant Weights. The population which we wish to represent by the non-participant sample is the total number of PG&E commercial premises (228,869) that did not participate in the 1994 PG&E Program. The specific procedure for calculating the premise-level weights used in this analysis can be found in Appendix H.

Addressing Problems in the Model

Investigators who use ordinary least squares techniques can experience a number of problems that result in biased or inefficient estimates. There are various techniques for detecting and for correcting these types of problems. Listed below are the potential problems that were addressed as part of this analysis. Some correction techniques are mentioned, but a full description of the process will be reserved for the discussion of net impact results in Section XII.

Heteroskedasticity. Heteroskedasticity refers to the situation where the variances around estimates are different for different levels or values of the predicted variable. This problem is common in cross-sectional analyses, but does not result in biased estimates; rather, it results in inefficient estimates. The first step taken to identify this problem was to plot the residuals against the predicted values of the dependent variable. This allows visual identification of situations where the differences between predicted values and observed values are larger at some points of the regression line than others. Most commonly, heteroskedasticity takes the form of larger variances for higher values of the predicted variable. In addition to visual inspection of residuals plotted against the predicted values, the more formal Breusch/Pagan test was performed.

The process of correcting for heteroskedasticity is not predictable. The correction depends on the form of the relation between the predicted variable and the error. The researcher tries different corrections for different functional problems and evaluates the results to determine whether the correction is appropriate. Sometimes the problem can be corrected or reduced by adding variables to the model that will explain the additional variance.

Outliers and Influential Observations. The ordinary least squares method is very susceptible to the influence of cases that have extreme values. The bulk of the cases may be clustered in a rather tight area, with one case residing far away from the rest on the independent variable. This extreme case would have a very strong impact on the estimate of the regression coefficient, and would result in a biased estimate. Because of this influence on the prediction, such cases often cannot be detected by visual inspection or by observation of errors. This is because the prediction "line" may be close to the outlier *because* of its influence. This problem can be overcome by the DFFITS procedure which calculates a predicted value two ways, once with a potential influential observation and once without it. If there is a large difference between the two, the case is considered influential.

A second test also estimates the model with and without the observation and then the difference between the two coefficients reflects the degree of influence. This is the DFBETA difference. These methods were employed in the current analysis toward detecting and correcting for influential cases.

Multicollinearity. Multicollinearity refers to the situation where two or more independent variables in a model are highly intercorrelated. This level of intercorrelation causes difficulties in the model. Specifically, multicollinearity results in higher variances for both predicted and explanatory variables. It also creates difficulty in partitioning variance among the competing explanatory variables. First, however, the problem must be detected. There are several ways to approach this task.

The simplest method to begin searching for multicollinearity is to compare the significance probabilities (p values) associated with the overall model compared to the p values for the partial coefficients for the explanatory variables. If there is a large discrepancy, multicollinearity should be suspected. In other words, if the overall model fits the data very well so that the p value is very small (e.g., .0001), but the p values for the individual coefficients are substantially larger, this indicates that variance cannot be partitioned into the various explanatory factors, and this implies strong linear relations among them.
Another approach to detecting multicollinearity is to test for variance inflation factors. A way to do this is to regress each explanatory variable on all other variables in the model. This allows the investigator to calculate a variance inflation factor by this equation:

$$\frac{1}{(1-R_i^2)}$$

where R_i^2 is the coefficient of determination for the regression of the ith independent variable on all other independent variables. This result is a measure of the instability of the coefficient estimate. Meyers (1990) indicates concern when values exceed 10.

Another approach to detection is recommended by Belsley et al (1980, chapter 3) and involves the analysis of structure. This approach entails the eigenvalues of the correlation matrix of the set of independent variables. The square root of the ratio of the largest to smallest eigenvalue is called the condition number which provides a single statistic for indicating the severity of multicollinearity.

Once detected, there is no consensus on what to do about it. Some recommend doing nothing. Others recommend obtaining more data, which, given both time and budget constraints, is unfeasible. Omitting one of the variables implicated is perhaps the most common approach. However, this makes sense only if the true coefficient of the omitted variable is zero. If the true coefficient of that variable is not zero, however, a specification error is created. Yet another approach is to group the collinear variables together to form a composite index capable of representing the group of variables by itself.

The various approaches that we took were a function of the specific situations we encountered in the analysis. In the results section, we describe our specific approaches to the problems and provide rationales.

D. Data Dictionary

Following is a description of the variables that are used in the billing regression analysis of net-to-gross ratio.

Variable Name	Variable Description
ADDAC	Coded 1 if cooling equipment added outside program.
ALLSR	Sum of all self-reported equipment installations, adjusted for effect period
ANYSR	Coded 1 if premise self-reported any HVAC-related equipment, 0 otherwise
AUDIT	Coded 1 if respondent self-reported receiving an audit, 2 otherwise.
CDDM	Monthly mean of cooling degree days, pre installation
CLINIC	Coded 1 if premise is a clinic, -1 if misc., 0 otherwise.
COMSERV	Coded 1 if premise is commercial services, -1 if misc., 0 otherwise.
CPIM	Mean of monthly of consumer price index, pre installation
DIFAGMN	Pre/post installation difference in mean kWh of 228,000 premises divided into 2-digit SIC and climate zone groups, with appropriate value assigned to each sample premise. Pre/post difference taken by subtracting post from pre kWh for comparable months.
DIFCDDMN	Pre/post installation difference in mean cooling degree days for closest weather station for each sample premise. Pre/post difference taken by subtracting post from pre cdd's for comparable months.
DIFCPIMN	Pre/post installation difference in mean statewide Consumer Price Index. Pre/post difference taken by subtracting post from pre CPI for comparable months.
DIFEMP2	Pre/post installation difference in mean employment rates. Pre/post difference taken by subtracting post from pre employment for comparable months and deadbanding two months.
DIFEMPMN	Pre/post installation difference in mean employment rates . Pre/post difference taken by subtracting post from pre employment for comparable months.
DIFFHDD2	Pre/post installation difference in mean heating degree days for closest weather station for each sample premise. Pre/post difference taken by subtracting post from pre hdd's for comparable months and deadbanding two months.

Variable Name	Variable Description
DIFHDDMN	Pre/post installation difference in mean heating degree days for closest weather station for each sample premise. Pre/post difference taken by subtracting post from pre hdd's for comparable months.
DIFKWH2	Pre/post installation difference in mean monthly kWh. Pre/post difference taken by subtracting post from pre employment for comparable months and deadbanding two months.
DIFKWHMN	Pre/post installation difference in mean monthly kWh. Pre/post difference taken by subtracting post from pre employment for comparable months
DIFPROP	Pre/post installation difference in monthly kWh as a proportion of the pre-installation kWh. Pre/post difference taken by subtracting post from pre kWh for comparable months.
EMPM	Mean of monthly employment rates, pre installation
FOOD	Coded 1 if premise is a food store, -1 if misc., and 0 otherwise.
HDDM	Mean of monthly of heating degree days, pre installation
HOTLMOTL	Coded 1 if premise is a hotel or motel, -1 if misc., 0 otherwise.
INCM	Mean of monthly taxable income, pre installation
KWHMPOST	Mean of monthly kWh post installation
KWHMPRE	Mean of monthly kWh, pre installation
LESHRS	Coded 1 if business hours decreased, 0 otherwise
LPREMN	Natural log of pre-installation kWh mean, using months comparable to post installation months.
LPSTMN	Natural log of post-installation kWh mean, using months comparable to pre-installation months.
MORHRS	Coded 1 if business hours increase, 0 otherwise.
OFFICE	Coded 1 if premise is a large or small office, -1 if misc., 0 otherwise.
OWN	Coded 1 if respondent owns building, 2 if leases it, 3 otherwise.
PART2	Coded 1 if 1994 HVAC program participant, 0 otherwise.
PERSREP	Coded 1 if premise is a personal repair business, -1 if misc., 0 otherwise.
PREKWHMN	Mean of pre-installation kWh, 12 months
PREMEAN	Mean of pre-installation kWh, using comparable months (compared to PSTMEAN)
PSTKWHMN	Mean of post-installation kWh, up to 12 months
PSTMEAN	Mean of post-installation kWh
RESPPAYS	Coded 1 if respondent pays electricity bill, 0 otherwise.
REST	Coded 1 if premise is a restaurant, -1 if misc., 0 otherwise.
RETAIL	Coded 1 if premise is a large or small retail store, -1 if misc., 0 otherwise.
SCHOOL	Coded 1 if premise is a primary or secondary school, -1 if misc., 0 otherwise.
SEPMET2	Coded 1 if business has separate meter, 0 otherwise.
SUMH	Number of measures (energy-using, or non-energy-using) installed outside the 1994 HVAC program.
SUMHN	Number of non-energy-using measures installed outside the 1994 HVAC program.

Variable Name	Variable Description
SUMHRS	Number of business hours increased or decreased, multiplied by fraction of time affecting the pre/post delta.
SUMHU	Number of energy-using measures installed outside the 1994 HVAC program.
SUMHVAC	Number of extra-program HVAC measures installed multiplied by fraction of time affecting the pre/post delta
SUMOPER	Sum of business hours and square footage
SUMPEQ	Sum of extra-program installations, all multiplied by the fraction of time each affected the pre/post delta
SUMPHRS	Number of business hours increased or decreased in the pre-installation period, multiplied by fraction of time affecting the pre/post consumption delta.
SUMPOHRS	Number of business hours increased or decreased in the post-installation period, multiplied by fraction of time affecting the pre/post consumption delta.
SUMSQF	Number of building square feet increased or decreased in the evaluation period, multiplied by the fraction of time affecting the pre/post consumption delta.
TAXM	Mean of monthly taxable sales
TOTLIT	Sum of all extra-program lighting installations
WARE	Coded 1 if premise is a refrigerated or non-refrigerated warehouse, -1 if misc., 0 otherwise.
WEEKHRS	Number of weekly business hours

E. References

Belsley, D.A., Kuh, E., and Welsch, R.E. (1980), *Regression Diagnostics*, New York: John Wiley & Sons, Inc.

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X. Results of the Engineering Gross Impact Analysis

A. Summary of Methodology

A building clustering approach was developed to leverage detailed information about one building by applying the information to other similar buildings, thus maximizing the number of sites that could be analyzed. Prior to the on-site survey, the 139 sites chosen for the engineering impact evaluation were divided into two groups, a cluster group of 60 sites and a matched pair group of 79 sites. Sites in the cluster group received a more intensive on-site survey and a DOE 2.1E analysis calibrated to monthly bills. The initial analysis of the cluster sites was first completed, and then information from that analysis supported the matched pair analysis. These analyses are described in more detail below. An additional analysis was also performed to estimate the effect that rebated energy-efficient lighting had on HVAC impacts. The work done to quantify the interaction between HVAC and lighting measures is discussed in Section XIII.

Cluster Analysis: On-site surveys for the 60 cluster sites involved collecting data to characterize the as-built and pre-measure capacity, efficiency, and quantity of the measure-affected equipment. Surveyors also collected data on the type of HVAC system, operating schedule, control settings and other performance parameters, as well as the operating schedule for internal loads in the conditioned spaces served by the affected HVAC system, the power density of internal loads in those spaces, and the building envelope characteristics (conditioned floor area, number of floors, percent glazing, and glazing type). The survey information served two purposes: to provide inputs to a DOE 2.1E model, and to allow for correction of telephone survey measurement error.

Once the surveys were completed, the cluster sites were grouped into five sets according to key building characteristics. These groups were: (1) school, (2) retail, (3) hospital, (4) office with central A/C, and (5) office with packaged A/C. After the clusters were defined, one calibration site was selected from each cluster. Using information from follow-up site visits and short-term end-use metering data, a site-specific DOE 2.1E model was developed for each of the calibration sites. These models were calibrated to 1994 weather, so that the simulations yielded HVAC use within 10% of a three-month summer HVAC target, maximum electric demand within 20% of billing data, and energy use within 10% of the bills for all fuels. From three of the five clusters, a test site was chosen. These three sites were used to test the impact of site specific envelope data on the estimate of savings for cluster sites. These sites were calibrated twice: as though they were a calibration site (except for end use metering) and as though they were a cluster site. Information from this test site analysis was used to confirm the validity of the clustering approach.

Each of the remaining 52 cluster sites was matched with one of the eight calibration or test DOE 2.1E models, according to building and HVAC system characteristics. Key parameters in the model, such as thermal zoning, end-use schedules, and equipment efficiencies, were adjusted to match the cluster site characteristics. As-built consumption for each site was calibrated to within 10% of billed kWh and 20% of kW for a calibration period in 1994. After calibration, the cluster model was rerun using typical weather for the pre-condition, as-built, and when appropriate, Title 20 baseline cases. Gross savings were calculated by subtracting as-built consumption under typical weather conditions from pre-condition consumption.

Matched-Pair Analysis: On-site survey data for the 79 matched-pair sites were similar to those for the cluster sites, although with somewhat less detail about the specifics of the HVAC system. Based on data about building type, size, envelope characteristics and HVAC system type, each matched-pair site was paired with an appropriate cluster site. Key parameters of the DOE 2.1E model for that cluster site, such as HVAC schedules, setpoints, and glazing percentages, were then modified to reflect the matched-pair as-built and pre-measure conditions. As with the cluster analysis sites, gross savings were calculated by subtracting as-built consumption under typical weather conditions from pre-condition consumption.

B. Cluster Test Site Comparison

Three test sites were modeled as both calibration and cluster sites to determine what effect the clustering process would have on the accuracy of the savings estimates. The three sites were deliberately chosen to represent a range of system types, building types, and HVAC measures. Consumption and savings estimates for the three sites are shown below in Table X-1. The aggregated estimates showed very small differences: the sum of the as-built consumption for the three buildings, for instance, showed a difference of 2% between the two methods. Aggregate electric consumption savings estimates were within 1.2% of each other; aggregate gas savings were within 13.7% of each other. Overall, the total savings (both electric and gas combined) differed by 11.7%. These results confirmed that DOE 2.1E modeling using a clustering approach yielded savings estimates reasonably close to those generated by detailed, site-specific DOE 2.1E models. The test site comparison also revealed several modeling guidelines that were subsequently used to improve the accuracy of the cluster site model savings estimates. Two important guidelines were: (1) to match cluster site and calibration site model thermal zones as closely as possible and (2) to calibrate both gas and electric consumption individually, rather than calibrating only to total energy consumption.

C. Comparison of Evaluation and Program Data Base Estimates

Tables X-2, X-3, and X-4 compare program data base and evaluation estimates of electric consumption, electric coincident peak demand, and gas consumption savings, respectively. The estimates shown in these particular tables are unweighted so that they represent only the 173 items that received engineering surveys, and not the entire population of items. Presenting these unweighted results makes it easier to isolate and examine the reasons for differences between program and evaluation estimates. The tables indicate the percentage of items where analysts found a significant difference between data base and evaluated values for equipment capacity, efficiency, or, when applicable, equivalent full load cooling hours. Any difference in these values greater than 20% that subsequently resulted in a greater than 10% difference in the savings estimates was deemed significant. In general, 43% of the items had a significant difference in equivalent full load hours (EFLH), 16% had capacity differences, and 11% had discrepancies in efficiency.

Table X-1: Cluster Test Site Comparison

	TEST METHOD	CLUSTER METHOD	% DIFFERENCE
SITE 1: Office with packaged A/C units			
Total As-built Usage (kWh/year)	1,374,917	1,373,978	-0.07%
Electric Savings (kWh/year)	9,059	15,819	74.6%
Gas Savings (kWh/year)	100,994	133,449	32.1%
Total Savings (kWh/year)	110,053	149,268	35.6%
SITE 2: Office with chillers			
Total As-built Usage (kWh/year)	1,252,969	1,198,201	-4.3%
Electric Savings (kWh/year)	32,249	21,139	-34.4%
Gas Savings (kWh/year)	--	--	--
Total Savings (kWh/year)	32,249	21,139	-34.4%
SITE 3: School with absorption chillers			
Total As-built Usage (kWh/year)	782,363	770,643	-1.5%
Electric Savings (kWh/year)	139,395	145,884	4.6%
Gas Savings (kWh/year)	747,736	831,270	11.1%
Total Savings (kWh/year)	887,131	977,154	10.0%
TOTAL FOR ALL SITES			
Total As-built Usage (kWh/year)	3,410,249	3,342,822	-2.0%
Electric Savings (kWh/year)	180,703	182,842	1.2%
Gas Savings (kWh/year)	848,730	964,719	13.7%
Total Savings (kWh/year)	1,029,433	1,147,561	11.5%

Table X-2: Unweighted Comparison of Data Base and Evaluation Electric Consumption Savings

			GWh Savings			Reasons for Change in Estimate (% of Items)		
Program	Domain	Number of Items	Data Base	Evaluated	% Change	Capacity	Efficiency	Equiv. Full Load Hours
Custom		**26**	**20.69**	**20.41**	**-1.4**	**38**	**4**	**19**
	Convert to VAV	3	1.62	1.51	-6.9	0	33	33
	Gas Absorption A/C	1	0.00	0.00	--	0	0	0
	HVAC Adjustable Speed Drive	6	1.37	1.21	-11.9	33	0	67
	HVAC Resize Motor/Compressor	2	6.23	6.44	3.3	0	0	0
	Install HVAC EMS	14	11.47	11.25	-1.9	57	0	0
Express		**147**	**11.21**	**6.26**	**-44.2**	**12**	**12**	**48**
	A/C: Central Air Cooled	32	0.10	0.06	-42.8	0	0	75
	Adjustable Speed Drive: HVAC Fan 50 l	15	0.90	1.83	101.9	13	0	0
	Cooling Tower	25	3.20	0.83	-74.0	28	12	68
	Evaporative Cooler	8	1.38	0.08	-94.4	38	0	0
	Other	17	0.75	0.19	-75.1	6	6	76
	Reflective Window Film	28	0.94	0.35	-62.9	11	50	0
	Water Chiller Air Cooled	5	0.84	0.44	-48.1	20	0	60
	Water Chiller Water Cooled	17	3.10	2.49	-19.5	6	0	76
Total		**173**	**31.91**	**26.67**	**-16.4**	**16**	**11**	**43**

Table X-3: Unweighted Comparison of Data Base and Evaluation Electric Coincident Peak Demand Savings

			MW Savings			Reasons for Change in Estimate (% of Items)		
Program	Domain	Number of Items	Data Base	Evaluated	% Change	Capacity	Efficiency	Equiv. Full Load Hours
Custom		**26**	**1.68**	**4.20**	**150**	**38**	**4**	**19**
	Convert to VAV	3	0.30	0.54	79.0	0	33	33
	Gas Absorption A/C	1	0	0	--	0	0	0
	HVAC Adjustable Speed Drive	6	0	0.31	--	33	0	67
	HVAC Resize Motor/Compressor	2	0.98	0.96	-2.0	0	0	0
	Install HVAC EMS	14	0.39	2.38	506	57	0	0
Express		**147**	**6.04**	**2.94**	**-51.3**	**12**	**12**	**48**
	A/C: Central Air Cooled	32	0.10	0.06	-35.9	0	0	75
	Adjustable Speed Drive: HVAC Fan 50 HP M	15	0	0.48	--	13	0	0
	Cooling Tower	25	2.63	0.66	-74.9	28	12	68
	Evaporative Cooler	8	0.51	0.08	-83.9	38	0	0
	Other	17	0.0013	0.07	5306	6	6	76
	Reflective Window Film	28	0.33	0.28	-16.1	11	50	0
	Water Chiller Air Cooled	5	0.53	0.40	-23.9	20	0	60
	Water Chiller Water Cooled	17	1.94	0.90	-53.6	6	0	76
TOTAL		**173**	**7.72**	**7.13**	**-7.6**	**16**	**11**	**43**

Table X-4: Unweighted Comparison of Data Base and Evaluation Gas Consumption Savings

			kTherms Savings			Reason for Change in Estimate (% of Items)		
Program	Domain	Number of Items	Data Base	Evaluated	% Change	Capacity	Efficiency	Equiv. Full Load Hours
Custom		**26**	**279.89**	**315.87**	**12.9**	**38**	**4**	**19**
	Convert to VAV	3	22.09	101.96	361.5	0	33	33
	Gas Absorption A/C	1	133.79	71.46	-46.6	0	0	0
	HVAC Adjustable Speed Drive	6	0	-1.85	--	33	0	67
	HVAC Resize Motor/Compressor	2	0	0	--	0	0	0
	Install HVAC EMS	14	124.01	144.30	16.4	57	0	0
Express		**147**	**0**	**-7.31**	--	**12**	**12**	**48**
	A/C: Central Air Cooled	32	0	0.10	--	0	0	75
	Adjustable Speed Drive: HVAC Fan 50 HP	15	0	-14.41	--	13	0	0
	Cooling Tower	25	0	0	--	28	12	68
	Evaporative Cooler	8	0	0.69	--	38	0	0
	Other	17	0	11.89	--	6	6	76
	Reflective Window Film	28	0	-5.65	--	11	50	0
	Water Chiller Air Cooled	5	0	0	--	20	0	60
	Water Chiller Water Cooled	17	0	0.06	--	6	0	76
Total		**173**	**279.89**	**308.56**	**10.2**	**16**	**11**	**43**

Electric Consumption

For the 173 items that received engineering analyses, overall electric consumption savings were evaluated to be 16.4% less than the program data base. The predominant reason for this difference appears to be discrepancies in EFLH. This difference was much more pronounced in the Retrofit Express Program, where 48% of the items had a significant difference in hours, compared to the Retrofit Customized Program, where only 19% of items were so. This is not surprising, since the Express Program relied on average values for all building types. For certain measures in particular, such as central air-cooled air-conditioning, water-cooled water-chillers, and programmable thermostats (which includes 16 of the 17 items classified under the "other" measure), 75% or more of the items had different EFLH.

Electric Demand

Overall, there were very large differences between the evaluation and data base estimates of demand savings, particularly for the Retrofit Custom Program. Evaluated savings for all 173 items were 7.6% lower than data base savings. The Custom Program showed 150% more savings, while the Express Program showed 51.3% less savings. Certain measures in particular evidenced dramatic differences: estimates for the installation of HVAC EMS measure, for instance, increased by 506% from the data base to evaluation. Compensating for these understated savings were several measures in the Express Program, such as the cooling tower and evaporative cooler measures, which overstated savings by 74.9% and 83.9% respectively.

Gas Consumption

Only three measures (conversion to VAV, gas absorption air conditioning, and installation of HVAC energy management systems) were credited with gas consumption savings in the PG&E program data base. These measures all fell under the Retrofit Customized rebate program. For the 173 evaluated items, the evaluated savings tracked data base savings fairly well: evaluated savings were 10.2% higher than the latter. The conversion to VAV and install EMS items showed 362% and 16.4% more evaluated savings, respectively, than credited in the program data base. There was only one surveyed item in the gas absorption air conditioning category. Evaluated savings for this item were 46.6% lower than the data base estimate. Although the Retrofit Express rebate program did not account for savings in gas consumption, the evaluation revealed that certain measures caused noticeable changes in gas use. The adjustable speed drive and reflective window film measures increased gas usage. These two measures, by reducing electric usage and demand, also reduced building internal gains, thus increasing the heating load during cooler weather. Programmable thermostats (under the "other" measure), by reducing or eliminating gas usage during building unoccupied periods, resulted in positive savings.

D. Effect of Title 20 Standards

Tables X-5, X-6, and X-7 show the effect of the Title 20 standards on electric consumption, electric coincident peak demand, and gas consumption savings estimates, respectively. These estimates are weighted so that they represent total program savings. The tables compare savings estimates at both the program and measure level using two different baseline conditions: Title 20 standards, and pre-measure conditions. The latter refers to the equipment types, efficiencies, and operating conditions in place before the HVAC measure was installed. Overall, removing the Title 20 constraints increased program electric consumption (GWh) savings estimates by 2%, electric peak demand (MW) estimates by 13%, and gas consumption (kTherm) estimates by 18%. On an absolute basis, the program savings estimates for electric usage, demand, and gas usage increased by 1.18 GWh, 2.29 MW, and 174.3 kTherms, respectively, without the Title 20 limits.

Since only central air-cooled air conditioning units, such as packaged direct expansion cooling units and heat pumps, fall under Title 20 constraints, only this particular measure shows a difference in evaluated savings estimates. For the central air-cooled air conditioning measure specifically, GWh savings increased by 112%, MW savings by 209%, and kTherms savings by 3,963%. The table also shows a slight increase in savings under the "Other" category, but this can be attributed to a central A/C unit that was misclassified as a packaged terminal air conditioner.

Part E below contains a detailed discussion of the effect of Title 20 standards for each of the PG&E costing periods.

E. Savings by Costing Period

The DOE 2.1E simulations were used to produce estimates of hourly change in demand over a typical meteorological year for each of the 139 engineering analysis sites. Aggregating these estimates yielded a program savings hourly load shape. Analyzing this aggregate load shape and the hourly demand estimates yielded estimates of annual gigawatt-hour, average and maximum megawatt, and maximum coincident demand savings for each of the five PG&E costing periods. PG&E defines summer as the period between May 1 and October 31. PG&E further divides summer into three periods: on-peak (12 P.M. to 6 P.M.), partial peak (8:30 A.M. to noon, and 6 P.M. to 9:30 P.M.), and off-peak (9:30 P.M. to 8:30 A.M., plus all day weekends). Winter (November 1 to April 30) is divided into partial peak (8:30 A.M. to 9:30 P.M.) and off-peak (9:30 P.M. to 8:30 A.M.) periods.

The results for the non-Title-20 constrained case are shown in Table X-8, and results assuming a Title 20 baseline are shown in Table X-9.

Without Title 20 limits, the annual electric consumption savings are 50.54 GWh. 55 % of the savings occurs during the summer. Of these summer savings, 23 % occurs during the on-peak period, 24% occurs during the partial-peak period, and the remaining 53 % occurs during off-peak hours. Winter savings are split 61% partial-peak and 39 % off-peak. The overall average demand savings are 5.77 MW. The maximum average demand savings (7.99 MW), maximum coincident demand savings (11.15 MW), and maximum demand savings coincident with the PG&E system maximum (9.55 MW) occur during the summer on-peak costing period.

Results with Title 20 limits are similar. The annual electric consumption savings are 49.36 GWh. 56% of the savings occurs during the summer. Of these summer savings, 24% occurs during the on-peak period, 23% occurs during the partial-peak period, and the remaining 53% occurs during off-peak hours. Winter savings are split 60% partial -peak and 40 % off-peak. The average demand savings is 5.63 MW. As with the non-Title-20 results, the maximum average demand savings (8.26 MW), maximum coincident demand savings (10.3 MW) and maximum demand savings coincident with the PG&E system maximum (9.81 MW) occur during the summer on-peak costing period.

Table X-5: Effect of Title 20 Standards on Electric Consumption Savings Estimates

Program	Domain	Title 20 Evaluated Savings (GWh)	Non-Title 20 Constrained Evaluated Savings (GWh)	Increase in Savings Without Title 20 Constraints (GWh)	% increase
Custom		31.96	31.96	0.00	**0**
	Convert to VAV	3.01	3.01	0.00	**0**
	Gas Absorption A/C	0.00	0.00	0.00	**0**
	HVAC Adjustable Speed Drive	4.27	4.27	0.00	**0**
	HVAC Resize Motor/Compressor	9.66	9.66	0.00	**0**
	Install HVAC EMS	15.02	15.02	0.00	**0**
Express		17.40	18.57	1.18	**7**
	A/C: Central Air Cooled	1.02	2.16	1.14	**112**
	Adjustable Speed Drive: HVAC Fan 50 HP Max	5.66	5.66	0.00	**0**
	Cooling Tower	1.20	1.20	0.00	**0**
	Evaporative Cooler	0.20	0.20	0.00	**0**
	Other	2.49	2.53	0.04	**2**
	Reflective Window Film	0.90	0.90	0.00	**0**
	Water Chiller Air Cooled	1.92	1.92	0.00	**0**
	Water Chiller Water Cooled	4.01	4.01	0.00	**0**
Total		49.36	50.54	1.18	**2**

Table X-6: Effect of Title 20 Standards on Electric Coincident Peak Demand Savings Estimates

Program	Domain	Title 20 Evaluated Savings (MW)	Non-Title 20 Constrained Evaluated Savings (MW)	Increase in Savings Without Title 20 Constraints (MW)	% increase
Custom		9.18	9.18	0.00	**0**
	Convert to VAV	1.08	1.08	0.00	**0**
	Gas Absorption A/C	0.00	0.00	0.00	**0**
	HVAC Adjustable Speed Drive	1.19	1.19	0.00	**0**
	HVAC Resize Motor/Compressor	1.44	1.44	0.00	**0**
	Install HVAC EMS	5.46	5.46	0.00	**0**
Express		8.57	10.86	2.29	**27**
	A/C: Central Air Cooled	1.04	3.21	2.17	**209**
	Adjustable Speed Drive: HVAC Fan 50 HP Max	1.43	1.43	0.00	**0**
	Cooling Tower	0.95	0.95	0.00	**0**
	Evaporative Cooler	0.19	0.19	0.00	**0**
	Other	0.83	0.95	0.12	**14**
	Reflective Window Film	0.74	0.74	0.00	**0**
	Water Chiller Air Cooled	1.78	1.78	0.00	**0**
	Water Chiller Water Cooled	1.60	1.60	0.00	**0**
Total		17.75	20.04	2.29	**13**

Table X-7: Effect of Title 20 Standards on Gas Consumption Savings Estimates

Program	Domain	Title 20 Evaluated Savings (kTherms)	Non-Title 20 Constrained Evaluated Savings (kTherms)	Increase in Savings Without Title 20 Constraints (kTherms)	% increase
Custom		814.40	814.40	0.00	**0**
	Convert to VAV	203.92	203.92	0.00	**0**
	Gas Absorption A/C	71.46	71.46	0.00	**0**
	HVAC Adjustable Speed Drive	-6.84	-6.84	0.00	**0**
	HVAC Resize Motor/Compressor	0.00	0.00	0.00	**0**
	Install HVAC EMS	545.86	545.86	0.00	**0**
Express		156.81	331.14	174.33	**111**
	A/C: Central Air Cooled	4.40	178.73	174.33	**3,963**
	Adjustable Speed Drive: HVAC Fan 50 HP Max	-60.27	-60.27	0.00	**0**
	Cooling Tower	0.00	0.00	0.00	**0**
	Evaporative Cooler	1.20	1.20	0.00	**0**
	Other	226.70	226.70	0.00	**0**
	Reflective Window Film	-15.35	-15.35	0.00	**0**
	Water Chiller Air Cooled	0.00	0.00	0.00	**0**
	Water Chiller Water Cooled	0.12	0.12	0.00	**0**
Total		971.21	1,145.54	174.33	**18**

Table X-8: Summary of Evaluation Results by Costing Period (Pre-Condition Baseline)

PG&E Costing Period	Annual GWh Savings	Average MW Savings	Maximum MW Savings	Hour of Maximum MW Savings	Hour of PG&E System Maximum	MW Savings Coincident with System Max
Summer On-Peak						
May 1 to Oct 31 12 PM-6 PM	6.33	7.99	11.15	3:00 PM	3:30 PM	9.55
Summer Partial Peak						
May 1 to Oct 31 8:30 AM-noon 6 PM-9:30 PM	6.59	8.32	10.00	7:00 PM	6:00 PM	9.51
Summer Off-Peak						
May 1 to Oct 31 9:30 PM-8:30 AM All day weekends	14.99	5.29	10.63	3:00 PM	10:00 PM	5.24
Winter Partial Peak						
Nov 1 to Apr 30 8:30 AM-9:30 PM	13.72	6.32	9.60	4:00 PM	6:00 PM	5.53
Winter Off-Peak						
Nov 1 to Apr 30 9:30 PM-8:30 AM	8.91	4.10	7.64	9:00 AM	8:00 AM	4.65
Total/Maximum	**50.54**	**5.77**	**11.15**	**3:00 PM**	**3:30 PM**	**9.55**

Table X-9: Summary of Evaluation Results by Costing Period (Title 20 Baseline)

PG&E Costing Period	Annual GWh Savings	Average MW Savings	Maximum MW Savings	Hour of Maximum MW Savings	Hour of PG&E System Maximum	MW Savings Coincident with System Max
Summer On-Peak						
May 1 to Oct 31	6.54	8.26	10.30	5:00 PM	3:30 PM	9.81
12 PM-6 PM						
Summer Partial Peak						
May 1 to Oct 31	6.50	8.21	9.60	12:00 PM	6:00 PM	8.85
8:30 AM-noon						
6 PM-9:30 PM						
Summer Off-Peak						
May 1 to Oct 31	14.74	5.21	9.79	1:00 PM	10:00 PM	5.22
9:30 PM-8:30 AM						
All day weekends						
Winter Partial Peak						
Nov 1 to Apr 30	12.93	5.95	8.92	4:00 PM	6:00 PM	5.06
8:30 AM-9:30 PM						
Winter Off-Peak						
Nov 1 to Apr 30	8.65	3.98	7.13	9:00 AM	8:00 AM	4.21
9:30 PM-8:30 AM						
Total/Maximum	**49.36**	**5.63**	**10.30**	**5:00 PM**	**3:30 PM**	**9.81**

Table X-10: Comparison of Title-20 and Pre-Condition Baseline Electric Savings Estimates

PG&E	Savings Increase from Title 20 to Non-Title 20 Baseline					
Costing Period	Annual MWh Savings	% Annual MWh Savings	Average kW Savings	% Average kW Savings	Maximum kW Savings	% Max kW Savings
Summer On-Peak						
May 1 to Oct 31 12 PM-6 PM	-210.9	-3.33	-266	-3.33	850	7.62
Summer Partial Peak						
May 1 to Oct 31 8:30 AM-noon 6 PM-9:30 PM	90.5	1.37	114	1.37	399	3.99
Summer Off-Peak						
May 1 to Oct 31 9:30 PM-8:30 AM All day weekends	251.8	1.68	89	1.68	846	7.96
Winter Partial Peak						
Nov 1 to Apr 30 8:30 AM-9:30 PM	788.8	5.75	363	5.75	672	7.00
Winter Off-Peak						
Nov 1 to Apr 30 9:30 PM-8:30 AM	258.6	2.90	119	2.90	507	6.64
Total/Maximum	**1,178.6**	**2.39**	**135**	**2.39**	**850**	**8.25**

Table X-10 shows the absolute and percent increase in savings resulting from removing the Title 20 constraint from the baseline case. For all of the costing periods except for summer on-peak, Title 20 reduced annual electric consumption and average demand savings by anywhere from 1.37% during summer partial peak to 5.75% during winter partial peak. Summer on-peak savings actually increased by 3.33% because of Title 20, i.e., the more efficient base case resulted in higher energy use than the less efficient base case. One possible explanation for this counterintuitive result could lie with the higher efficiencies of Title-20-mandated equipment. Title 20 only affected central air-cooled air conditioners. If in the non-Title-20 case the air conditioners were running at full load, they would have been operating at high efficiencies. To meet the same cooling load, Title 20 air conditioners might be operating at less efficient part-load conditions. The net effect of Title 20 would be to increase cooling consumption. Such an effect, however, appears to be masked in the maximum coincident demand savings comparison. For all five costing periods, savings increased going from the Title 20 to the non-Title 20 case. The difference between maximum demand savings estimates ranged from 507 kW during winter off-peak to 850 kW during summer on-peak. The percent increase in savings ranged from 3.99% for summer partial-peak to 7.96% for summer off-peak.

One caveat: results for MW savings should be kept in perspective, since DOE 2.1E is not a particularly good tool for estimating peak demand. DOE 2.1E simulations yield hourly demand results, while utility demand metering typically occurs at 15 minute intervals. The simulations cannot model very short-term energy consumption patterns, such as air conditioning equipment cycling on and off several times in an hour. Maximum peak demand often occurs over a very short period of time (less than an hour), when high loads for several end uses coincide. For example, the peak load in a building for a particular month might occur once that month for a twenty minute period, when most building lights are on, the HVAC system is operating at full load, and miscellaneous equipment (such as welding machines or process equipment) is in use. DOE 2.1E cannot always capture such short-term events, and thus does not always provide an accurate picture of peak demand.

Over a longer period such as a year, though, such fluctuations in demand tend to average out, so that DOE 2.1E can provide good estimates of annual consumption. Estimates for a period less than a year, consequently, may have higher uncertainty. For the costing periods above, the summer on-peak period estimates of savings might be expected to have the highest uncertainty, because the lowest number of hours occurs during that period. Conversely, the winter partial-peak and off-peak periods have the highest number of hours and thus the highest degree of certainty.

F. Savings Realization Rates

Tables X-11, X-12, and X-13 show estimates of annual electric consumption (GWh), electric peak demand (MW), and gas consumption (kTherm) savings and realization rates, respectively. Each table also lists the relative error at a 90% confidence level. The relative error states, as a percentage, the upper and lower limits within which one could be 90% confident the true estimate of savings lies. Small sample counts relative to the population count, as well as large variations in individual estimates, can all increase the relative error. As a result, relative errors are very high for many of the individual measures, but are lower at the program and total level.

Savings estimates in the tables are broken down by PG&E program and HVAC measure and assume baseline conditions meeting Title 20 limits. Overall, it was estimated that the 1994 HVAC Retrofit Program yielded a GWh realization rate of 0.76 (with a relative error of 19.3%), a MW realization rate of 1.16 (relative error of 15.6%), and a kTherm realization rate of 1.78 (relative error of 44%).

The Retrofit Custom Program, which accounted for 54% of PG&E's estimate of program savings, had a much higher GWH realization rate (90%) than the Retrofit Express Program (59%). GWh realization rates for each measure varied dramatically. They tended to be high (84%-103%) in the custom program, although the relative error was correspondingly high because of the small number sampled. Certain Express Program measures, most notably cooling towers (26%), evaporative coolers (7%), and reflective window film (30%), had especially poor GWh realization rates. For these three measures, the program data base consistently overstated estimated savings.

Even greater discrepancies exist with the MW realization rates. In many cases, PG&E claimed little or no electric demand, when in fact, engineering evaluations indicated they were significant. For instance, evaluated HVAC energy management system (EMS) measure savings were 5.46 MW, compared to the 0.56 MW PG&E claimed. Primarily because of this, the MW realization rate for the Retrofit Customized Program is high (3.48). Realization rates in the Retrofit Express Program are on average much lower. PG&E claimed MW savings for all Express measures except adjustable speed drives. The evaluation found savings for all measures, although with the exception of the "other" category (primarily programmable thermostats), the realization rates were less than one. The cooling tower and evaporative cooler measures yielded low realization rates (0.25 and 0.19, respectively); all other measures except for "other" ranged from 0.55 to 0.76. The programmable thermostats in the "other" category yielded a very high realization rate of 6.60. Overall, the Retrofit Express Program MW realization rate was 0.67. As was mentioned in Part E above, though, MW savings results may not be especially reliable because of the limitations of the DOE 2.1E simulation.

Realization rates for gas consumption also ranged dramatically, although the relative error at all levels is rather high. PG&E only claimed gas savings for the conversion to VAV, gas absorption A/C, and HVAC EMS measures in the Retrofit Customized Program, and claimed no gas savings in the Retrofit Express Program. Our evaluation yielded gas savings for nearly every measure. Some of these savings, though, were negative: the two adjustable speed drive measures yielded negative savings, as did the reflective window film measure. These measures reduced internal gains, thereby increasing the heating load and resulting in negative gas savings. Two measures in particular resulted in much higher gas savings than expected. The conversion to VAV measure had a realization rate of 4.62. The "other" category, consisting primarily of programmable thermostats, accounted for 226.7 kTherms of savings, or 23% of the total program gas savings. Since the program estimated no savings, the realization is undefined for the measure, but the measure did dramatically improve the overall realization rate to 1.78.

Table X-11: Electric Consumption Savings Realization Rates by Program and Measure

		GWh Savings			
		PG&E Data		Realization	RE @
Program	**Domain**	**Base Values**	**Evaluated**	**Rate**	**90% CL**
Custom		**35.46**	**31.96**	**0.90**	**28.25**
	Convert to VAV	3.23	3.01	0.93	**71.53**
	Gas Absorption A/C	0.00	0.00	--	**0.00**
	HVAC Adjustable Speed Drive	4.99	4.27	0.85	**49.33**
	HVAC Resize Motor/Compressor	9.35	9.66	1.03	**84.11**
	Install HVAC EMS	17.88	15.02	0.84	**16.84**
Express		**29.64**	**17.40**	**0.59**	**17.40**
	A/C: Central Air Cooled	1.58	1.02	0.65	**23.94**
	Adjustable Speed Drive: HVAC Fan 50 HP	2.66	5.66	2.13	**39.15**
	Cooling Tower	4.56	1.20	0.26	**33.42**
	Evaporative Cooler	2.65	0.20	0.07	**54.78**
	Other	6.91	2.49	0.36	**55.29**
	Reflective Window Film	3.00	0.90	0.30	**40.19**
	Water Chiller Air Cooled	3.70	1.92	0.52	**42.34**
	Water Chiller Water Cooled	4.59	4.01	0.87	**28.84**
Total		**65.10**	**49.36**	**0.76**	**19.29**

Table X-12: Electric Coincident Peak Demand Savings Realization Rates by Program and Measure

		MW Savings			
		PG&E Data		Realization	RE @
PROGRAM	DOMAIN	Base Values	Evaluated	Rate	90% CL
Custom		**2.64**	**9.18**	**3.48**	**23.07**
	Convert to VAV	0.61	1.08	1.79	**90.95**
	Gas Absorption A/C	0.00	0.00	--	**0.00**
	HVAC Adjustable Speed Drive	0.00	1.19	--	**46.68**
	HVAC Resize Motor/Compressor	1.47	1.44	0.98	**45.17**
	Install HVAC EMS	0.56	5.46	9.74	**30.52**
Express		**12.70**	**8.57**	**0.67**	**20.81**
	A/C: Central Air Cooled	1.56	1.04	0.67	**32.73**
	Adjustable Speed Drive: HVAC Fan 50 HP M	0.00	1.43	--	**36.19**
	Cooling Tower	3.75	0.95	0.25	**35.04**
	Evaporative Cooler	0.98	0.19	0.19	**64.06**
	Other	0.13	0.83	6.60	**79.42**
	Reflective Window Film	1.05	0.74	0.71	**36.64**
	Water Chiller Air Cooled	2.34	1.78	0.76	**79.13**
	Water Chiller Water Cooled	2.89	1.60	0.55	**26.24**
TOTAL		**15.34**	**17.75**	**1.16**	**15.60**

Table X-13: Gas Consumption Savings Realization Rates by Program and Measure

		kTherms Savings			
PROGRAM	DOMAIN	PG&E Data Base Values	Evaluated	Realization Rate	RE @ 90% CL
Custom		**544.85**	**814.40**	**1.49**	**48.98**
	Convert to VAV	44.18	203.92	4.62	**102.16**
	Gas Absorption A/C	133.79	71.46	0.53	**0.00**
	HVAC Adjustable Speed Drive	0.00	-6.84	--	**70.00**
	HVAC Resize Motor/Compressor	0.00	0.00	--	**0.00**
	Install HVAC EMS	366.87	545.86	1.49	**62.31**
Express		**0.00**	**156.81**	**--**	**97.30**
	A/C: Central Air Cooled	0.00	4.40	--	**152.53**
	Adjustable Speed Drive: HVAC Fan 50 HP	0.00	-60.27	--	**82.63**
	Cooling Tower	0.00	0.00	--	**99.81**
	Evaporative Cooler	0.00	1.20	--	**107.39**
	Other	0.00	226.70	--	**63.26**
	Reflective Window Film	0.00	-15.35	--	**89.20**
	Water Chiller Air Cooled	0.00	0.00	--	**0.00**
	Water Chiller Water Cooled	0.00	0.12	--	**77.65**
Total		**544.85**	**971.21**	**1.78**	**43.97**

XI. Results of the Statistical Gross Impact Analysis

A. Introduction

The primary objective of the gross savings analysis was to estimate a realization rate applicable to all HVAC measures for which rebates were paid in 1994 through PG&E's commercial retrofit programs, indicating what proportion of ex-ante savings estimates were "realized." Realized savings are those consumption increments or decrements that follow upon measure installation that cannot be accounted for by facility or environmental changes that coincide with the measure installation, i.e., changes that would have diminished energy use regardless of the efficiency of the program installation. The methodology for this analysis involved a monthly billing analysis, in which survey data, program tracking information on savings, enhanced engineering estimates of savings, and weather data were combined to isolate the gross impacts of the HVAC measures. A secondary goal of the analysis was to investigate the impact of the interaction of paid 1994 lighting measure installation on paid 1994 HVAC measure installations.

The final model was estimated on 16,742 monthly billing/weather records pertaining to 374 locations (identified by unique values of PREMID). Billing months covered the period January 1992 through September 1995. For a given customer, all bills were used except a small number that were discovered to include leading zeroes (rather than blanks which had been previously flagged for deletion). It will be noted that although 438 participant locations were part of the achieved survey sample with usable billing records, 64 were excluded from the analysis, due to (1) survey evidence that they had added HVAC equipment and not performed any replacement/retrofits, (2) evidence from the engineering analysis that the installation was increasing consumption due to increased level of service, (3) nine or more imbedded zeroes in the consumption stream of one of the PREMID's constituent accounts, (4) no installations made, according to available flags, within the year 1994. The last two of the 64 were two PREMID's identified as extreme outliers in the annual change models used in the net impact analysis. The weight RWT3A, a relative weight designed for use with the sample of 438 participants, and 442 nonparticipants, was used in all of this analysis, except for adjustments made in-stream during estimation to modify the weights of highly influential cases (see discussion below). All analysis weights are discussed in Appendix H.

The general approach to estimation consisted of estimating a cross-sectional time series regression over the 374 customers, with the following regressors receiving consideration:

1. Enhanced estimates of full-delta[1] savings for measures in the non-energy using HVAC or energy using HVAC meta-domains. These include variables which have been "de-weather normalized" for use in the regression calibration, and variables which are in the original normal-weather form provide by the engineering analysis.

2. Program database estimates of full-delta savings for HVAC measures not included in the engineering analysis sample, but ratio-improved using information from the engineering analysis sample. Weather-denormalized estimates were used in calibration of the regressions.

3. Program database estimates of lighting savings (energy-using equipment were considered separate from control or other measure savings).

4. Survey data capturing square footage changes and weekly operating hours changes.

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[1] "Full delta" is defined as the kWh consumption of the old HVAC equipment minus the kWh consumption of the new efficient HVAC equipment. This represents the decrease in kWh consumption that one would expect to see in the customer billing data and is therefore what is needed for inclusion in the regression models.

5. Survey data indicating self-reported installations, by date, of extra-program equipment likely to change load significantly.

6. Weather data, including observed cooling degree days, using building type-specific bases, observed heating degree days at base 60 degrees, and normal weather counterparts of these. Additionally, an exercise was conducted to improve the local precision of the normal weather, by allocating normal weather CDD for climate zones to specific weather station/local office CDD estimates, using local-to-region ratios in the observed monthly data.

7. Aggregate economic time-series, including 1) total quarterly commercial employment by metropolitan statistical area (MSA), 2) territory-wide monthly totals of kWh usage by 2-digit SIC, to be linked as SIC-appropriate to each customer, 3) territory-wide monthly totals of kWh usage by 3-digit SIC, and 4) monthly totals of kWh by climate zone and 2-digit SIC

B. Final Model

The intended approach was to include a SAE-based regression estimation, using the enhanced engineering estimates for 173 measures where possible, and improved PG&E priors when not. Additionally, the notion was to break out savings into separate SAE estimates for energy-using retrofits (HU) and non-energy-using HVAC control measures (HN). Effectively, the plan entailed possible inclusion of several SAE estimates in a customer's time series, where all HVAC-related variables (engineering priors) are "de-weather normalized:"

The idea of the analysis was to include as much separate information by estimate source and by energy-using and non-energy-using equipment in the regression as possible, in order to account for savings. Unfortunately, the enhanced PG&E priors performed poorly in the yearly savings models of this type, leading to an investigation of the ability of less complex dummy variables, particularly those representing PG&E installations, to account for consumption variation.

We will present evidence on the relative accuracy (ability to explain consumption) of the dummy variable versus SAE approach, and the results of a mixed approach. However, the final model selected will be described first.

This model was selected for its simplicity, built-in sensitivity to weather, and coverage of all measures in the program database for the 374 customers available to the billing analysis. It includes four terms allowing the inclusion of interaction effects between lighting and HVAC end uses, and adjusts for significant environmental and facility-specific changes over time. This model contains an intercept term generated in advance to identify the customer with a central consumption value, thereby absorbing individual-premise-based consumption variance as well as reducing computation time. This leads to a slight understatement of the variance of estimated coefficients in the model, since SAS does not take into account the fact that one degree of freedom has been taken per customer.

The model was estimated in two rounds via ordinary least squares, using participation weight RWT3. Round 1 included the calibration of an influence statistic, DFITTS. DFITTS values were reviewed by the program, and any customer with a value on any record greater than 1.0 had all of its records reweighted by .25 prior to re-estimation. Results of the re-estimation are given in Table XI-1.

Table XI-1: Final Gross Impacts Model

Variable	Variable Description	Parameter Estimate	Probability t
GLM_MEAN	Premise-based mean consumption	.999684	.0001
EUHU94D	Energy-using equip, on-site surveyed	-14218	.0001
EUHN94D	Non-energy-using equip, on-site surveyed	-10791	.0001
PKHU94D	Energy-using equip, not on-site surveyed	-1428	.29
PKHN94D	Non-energy-using equip, not on-site surveyed	-192	.86
EUHU94C	On-site surveyed energy-using equip x cooling degree days	83	.0001
EUHN94C	On-site surveyed non-energy-using equip x cooling degree days	30	.03
PKHU94C	Non-on-site surveyed energy-using equip x cooling degree days	1.2	.84
PKHN94C	Non-on-site surveyed non-energy-using equip x cooling degree days	-3.7	.54
EUHU94L	On-site surveyed energy-using lighting measure	-1487	.69
EUHN94L	On-site surveyed non-energy-using lighting measure	-186	.96
PKHU94L	Non-on-site surveyed energy-using lighting measure	-7325	.01
PKHN94L	Non-on-site surveyed non-energy-using lighting measure	-1474	.38
CDD	Cooling degree days	22	.0001
HDD60	Heating degree days-set point 60 degrees	-16	.0001
ETOT	Employment in California	2.7	.05
AGGSIC3	PG&E consumption & 3-digit SIC	.002	.04
SCHGHRS	Cumulative hours changes scaled by customers consumption	-.0001	.38
SCHGSQF	Cumulative changes in square footage scaled by customer consumption	-.000000004	.89
N		**376**	
R^2		**.989**	

Mean post installation consumption delta accounted for by the model: 2902
Mean post installation consumption delta in program savings: 3143
Estimated realization rate: 2902/3143

As specified, this model provides for interaction of lighting priors with HVAC measure installations. We do not include a simple stand-alone additive lighting term in the specification because of its redundancy in this particular sample, i.e., of the sample members with lighting, there are no customers with lighting but no HVAC measures. To capture the total impact of HVAC and HVAC/Lighting interaction, the model was evaluated over the sample, with coefficients for all HVAC-involved terms left to provide a "with-measure" condition, and set to zero to simulate the non-measure condition. While the regression was *estimated* on observed weather and "de-weather normalized" priors, calculation of program savings was accomplished using normal weather (TMY). Specifically, actual savings were calculated by multiplying the estimated parameters by the corresponding values on each variable twice, once with the participation variable set to 1, and another where it is set to 0. The total savings are added each time across customers.

The difference in the two totals reflects the savings. This calculation procedure was used with weather normalization. Note also that in other models that are mentioned in this text, where actual ex-ante HVAC estimates are provided instead of dummy variables, we evaluated the model using not only normal weather but "normal priors," i.e., not the priors that had been "de-weather normalized" via the log-log regression discussed in Chapter VI.

A variety of diagnostics, involving issues of reweighting, autocorrelation, and specification error are given in Appendix E covering the final model. Further discussion of the diagnostics results is in Subsection C of this Section (XI).

Description of Model Variables

The GLM_MEAN parameter is a regression staple used simply to center the consumption variance about each individual customer's consumption trajectory. Without this or other cross-sectional methods of absorbing individual-premise-based consumption variance, the other coefficients would be meaningless. The GLM_MEAN was calculated using PROC GLM prior to the regression, and on entry it always takes on a parameter of 1.0.

EUHU94D and EUHN94D are dummy variables indicating the presence in month t of an on-site surveyed piece of energy-using or non-using HVAC equipment, and PKHU94D and PKHN94D supply the same information about non-surveyed measures. Their coefficients indicate strong additive impacts of the equipment on savings.

EUHU94C and EUHN94C are dummy variable product terms, calculated as cooling degree days times the presence of the relevant piece of equipment, and the PKHU94C/PKHU94C pair are used in the same way for non-on-site surveyed customers. Coefficients indicate some additional temperature sensitivity in the on-site survey subsample.

EUHU94L through EUHN94L are product terms which are set to a value of 1 in the event that a given month also includes the presence of a lighting measure. All coefficients indicate, with caveats necessary, the increased benefit associated with a lighting measure in the presence of an HVAC measure. The caveat is important--the benefit may be merely an artifact of customer attributes or motivations that select them into a higher level of participation. The actual magnitude of the kWh reduction due to this interaction effect is very uncertain.

CDD is cooling degree days per month, calculated at a building type-specific base of 65 or 70 degrees.

HDD60 is heating degree days per month in the three digit SIC group to which the customer belongs, calculated at a base of 60 degrees.

ETOT is another measure of external change, the total quarterly commercial employment for the State of California. According to some conceptions of gross savings, these external changes must be adjusted for when analyzing a sample of participants.

SCHGHRS is a cumulative total of changing hours reported retrospectively by respondents, scaled by multiplying the reports by the customer's pre-program mean monthly consumption. This construction was an effort to mitigate the problem of heterogeneity in the cross-sectional pool by placing such changes in a roughly common metric.

CHGSQF is a similarly scaled change in square footage. Each serves as a relatively minor adjustment for changes coincident with possible gross savings.

Final Results of the Model

The realization rate on this regression is approximately .92, based on calculating, over all post-HVAC installation months, the regression-expected savings due to measure installation, and dividing into it, on a weighted basis, the tracking system monthly ex-ante estimates of savings.

C. Diagnostics for Final Model

In this section, we treat several issues regarding the final model: influential observations, multicollinearity, autocorrelation, Heteroskedasticity, specification bias, and the timing of the measurement of impact (dead banding).

Influence Diagnostics

Iteration 1 of the regressions identifies customers with 1 or more DFFITS values greater than 1.0, and rescores the weights for such customers by .25, to mitigate their influence without removing them from the system. To do more could risk distorting the reality that the regression is meant to sort out, although it should be noted that in a sample of this size this is a very *conservative* DFFITS level to base a decision upon.

Only three customers were weighted down in this way. Included in this group are two customers, one very large, which experienced a drop in consumption in the post-installation period.

SAS Proc Univariate output describing the customer-specific variable MAXDFIT (maximum value for all customer records) is given in Table 1 in Appendix E.

Multicollinearity

Table 2 in Appendix E provides standard SAS collinearity diagnostics, post-iteration 2, per Belsley, Kuh and Welsch (1980). The condition index for the last component of variance suggests that multicollinearity is not a serious problem in this specification on this data set, despite the use of some interaction terms.

Autocorrelation

Table 3 in Appendix E provides a pair of SAS PROC UNIVARIATE tables describing the distributions of customer-specific calculations of Durbin-Watson (DW) statistics and rho values. These tables make it clear that there is considerable intra-customer serial correlation to contend with. While this does not threaten the consistency of the estimates that have been calculated, it does make their statistical precision less than it could have been were serial correlation either not present or corrected.

Heteroskedasticity

To assess heteroskedasticity, we have simply correlated the absolute value of the residual from iteration 2 with variables in the model. Table 4 in Appendix E indicates that certain scale-related regressors do have a modest positive relationship with the size of the residual. Considering the variables which so correlate at more than 0.1, there is evidence that the magnitude of consumption, and therefore the likely magnitude of residuals from regression, are related to:

- the likelihood of being included in the on-site survey sample,

- the plausibly size-related incidence of performing both lighting and HVAC measures,
- the size of the global consumption in the SIC3 of reference, and
- variables which are consumption-scaled change variables.

However, none of the correlations seem large enough to warrant attention, and in fact are often the consequence of an effort (e.g., the scaling of changed hours), to more appropriately account for residuals among heterogeneous sites.

Specification Problems

A practical approach to the question of specification error is to determine whether there is a relationship between the regression residual and excluded variables of substantive relevance to consumption, or to savings. In Table 5 in Appendix E, we correlate the residual from iteration 2, labeled "RESID1" (despite its source), with a number of other variables available in the data set. There is no evidence that substantively relevant variables, including variables which report on change at the site, would make a sizable contribution to the regression. In fact, the only variables of any magnitude are excluded SAE priors of various types, supporting either the argument that priors add information to the regression or that they would distort true findings coming from a dummy variable regression. Generally, the SAE variables are negatively correlated with the model residual, coinciding with either argument.

Deadbanding

As an aspect of measurement, it is important to know whether impact estimates are affected by the timing of the indicator (dummy flag or SAE prior) that savings should be expected. A version of the final model was executed, with a 3 month deadband asymmetrically established that included our assumed month of installation based on dates in the Program Database. The results, shown in Table 6 in Appendix E indicate that the elimination of these records has little effect on the results reported in Table XI-1. The only coefficient changes of note involve previously and currently insignificant lighting interaction terms. The post-calculated gross realization rate of 0.97 is a very modest change from the .92 based on the final model run.

D. Alternate Specifications

A number of models varying from the specification of the final model were estimated and considered for use as the tool for estimating gross savings. Following are brief descriptions of two.

An Additive Model Using Mixed Priors

One model type considered involved use of the enhanced engineering savings estimates where available and dummy variables indicative of PG&E savings otherwise for HVAC installations. In this model, there is also a quantitative PG&E prior for lighting (variable name TRL94T). The coefficients for the enhanced engineering estimates are quite similar in magnitude to those observed in a model described in the next section which included only premises with enhanced engineering estimates. However, the realization rate for this model was 1.36, a number considered implausible. Thus, the model was rejected. The results of this model can be seen in Appendix E.

An Interaction Model

Another model considered was essentially the same as the above additive model, including mixed priors (enhanced engineering priors when available and dummy variables), and a quantitative PG&E prior for lighting. However, in this model, there was another dummy variable indicating coincident lighting and HVAC installations within the program. This dummy represents an interaction effect. This interaction will be discussed in Chapter XIII. The realization rate for this model was 1.44, also considered implausible. The full results of this model are contained in Appendix E.

E. Statistical Estimates of Gross Program Impact

The statistical estimates of gross savings and realization rates are summarized in Table XI-2 below. The statistical gross savings analysis yielded a gross realization rate for annual energy consumption (the ratio of evaluation gross savings to program gross savings) of 0.92.

Although the statistical model did not directly estimate a realization rate for demand impacts, the engineering analysis found that the primary reason for differences between program and evaluation savings estimates was discrepancies in assumed operating hours, rather than differences in equipment capacity. Table X-1 in Section X showed that of the engineering analysis items with a significant difference between program and evaluation savings estimates, the reason for the difference 43% of the time was different operating hours. In only 16% of the cases was the difference because of a discrepancy in capacity. Stated alternatively, for cases where these reasons for differences applied, 73% of the time the reason was a difference in assumed operating hours. It was felt that the engineering analysis, because it estimates demand more or less independently of operating hours, would yield a more accurate realization rate. Because of this, the statistical gross realization rate was adjusted upwards by multiplying the difference between the engineering and statistical realization rates (1.16 minus 0.92, which equals 0.24) by 73%, and adding this to the statistical realization rate. This yielded an adjusted realization of 1.09 for MW.

Table XI-2: Summary of Statistical Gross Analysis Results

	Electric Usage		**Electric Demand**		**Gas Usage**	
	GWh/yr (5)	90% CI (1)	MW (5)	90% CI (1)	kTherms/yr (5)	90% CI (1)
PG&E's PROGRAM DATA BASE						
Gross Savings	**65.10**	--	**15.34**	--	**544.9**	--
Net-to-Gross Ratio (2)	**0.71**	--	**0.68**	--	**0.75**	--
Net Savings	**46.45**	--	**10.49**	--	**408.6**	--
EVALUATION RESULTS						
Gross Realization Rate (3)						
Engineering	**0.76**	0.61 to 0.90	**1.16**	0.98 to 1.34	**1.78**	1.00 to 2.57
Statistical	**0.92**	0.72 to 1.12	**1.09 (4)**	**--**	**--**	--
Gross Savings						
Engineering	**49.36**	39.8 to 58.9	**17.75**	15.0 to 20.5	**971.2**	544 to 1398
Statistical	**59.89**	47.1 to 72.7	**16.77**	**--**	**--**	--

NOTES

1. Confidence interval (CI) at a 90% confidence level.
2. Assumes a net-to-gross ratio of 0.75 for Customized Program measures, 0.67 for Express Program measures.
3. Evaluation gross savings / program gross savings.
4. The statistical gross realization rate of 0.92 was adjusted upwards towards the engineering MW realization rate of 1.16 since the major reason for program/evaluation discrepancies was a difference in assumed operating hours.
5. These units apply to all number below except for realization rates and net-to-gross ratios.

XII. Results of the Net Impact Analyses

This section describes the results of our net impact analyses for retrofit HVAC measures for which rebates were paid during 1994. Three methods were used to estimate net-to-gross (NTG) ratios for these measures and these ratios were applied to statistically adjusted engineering estimates of gross savings, described in Section XI, to provide three estimates of net program impact. The results from each of the three analyses of NTG ratio are described below. This is followed by an analysis of spillover effects of the program. This section concludes with a summary of the program net impacts derived from these NTG ratios.

A. Self-Report Analysis of NTG Ratio

As described in Section VII, analyses of information obtained from the telephone survey of participants was used to produce an estimate of the NTG ratio for the paid 1994 HVAC measures. Program participants were asked how likely they would have been to install the same equipment if the rebate had not been available. If the business installed rated equipment they were asked how likely they would have been to install the same efficiency without the rebate. The more appropriate of those two questions was the core net-to-gross probability question for all respondents. The core question was modified if the company had heard about the program after selecting the equipment that they installed, as that information contradicts a claim that the program was influential in the decision. Hearing about the program after equipment selection implies a net-to-gross probability of "0", so the response to the core question was averaged with "0" in order to take account of both answers. On the other hand, if the respondent indicated that the equipment would have been installed one or more years later without the program (even if they would have installed the same thing), the core question value was changed to "1" because this evaluation assesses the first-year impacts of the program.

As shown in Table XII-1, weighting the results for the participant sample by the sample case weights and the avoided energy and capacity costs associated with the measure savings yielded a final net-to-gross ratio of .57. However, three other intermediate figures may be of some interest as well. First, the raw net-to-gross ratio based only on the telephone interview questions was .49. Another ratio was produced by weighting the raw number by the case weights. Case weights reflect only which of two savings domains and 17 measure domains the site fell into. Recall from the sampling sections of this report, that sites appeared in the high savings domain by installing a measure which, in the aggregate, contributed substantially to the program's total savings. Sites with measures in this domain had a higher likelihood of being selected into the sample This would translate into a small case weight. Also, some *measures* were sampled at a 100% rate, and would receive small case weights. The ratio produced by this weighting method is .49, the same result as the raw net-to-gross ratio. The fact that these two ratios are so similar probably reflects that installing efficient equipment outside the program is as likely (or unlikely) for members of the high savings domain as for the "other" domain, and for installers of all measure types. Bear in mind, though, that membership in the high savings domain does not necessarily mean that site savings were high--it could mean that the measure was a very common one (and therefore contributed a lot to program savings) or that it was indeed a very high energy saver.

Table XII-1: Calculated Net-to-Gross Ratios using Several Weighting Methods

Weighting Method	Resulting Net-to-Gross Ratio
Raw, unweighted	.49
Case weights	.49
kWh	.54
Avoided Costs	.57
N	430

The raw net-to-gross ratio was also weighted by the energy savings associated with each individual site. Weighting by this method results in a net-to-gross ratio of .54. This makes it clear that locations that produced high savings were somewhat more likely to be influenced by the rebate to do so than sites that produced small energy savings.

The avoided cost method weights each site's net-to-gross probability by the size of the energy savings, the capacity savings and the costing periods in which these savings appeared. The fact that this ratio was higher than any of the others reveals that those sites that experienced the highest savings, had the largest capacity savings, and produced them in the higher-cost time periods, were more likely to be influenced in their installation decisions by the rebate than other sites. However, the difference between the raw and the weighted net-to-gross ratio is quite small. This implies that there was not a very strong relation between savings and interview responses or between demand reduction and interview responses. This point can be illustrated by calculating Pearson correlation coefficients between raw net-to-gross probabilities and kWh savings, as well as kW reductions. The two correlations, are both .02. As expected, the correlations are positive indicating that higher savers were more likely to attribute the installation to the program than low savers. However, this tendency is not strong as shown by the small size of the coefficients, and this explains why the difference between the raw and weighted net-to-gross ratios is small.

Calculation of Uncertainty Range

The calculation of a confidence interval around the self-report-based net-to-gross ratio is not feasible because this requires calculation of a standard error of the weighted net-to-gross distribution. Calculating a standard error around the mean net-to-gross ratio assumes a distribution of weighted premise-based net-to-gross probabilities, and this is not feasible because the weighted versions of premise-based ratios do not vary between 0 and 1. However it was considered important to provide some measure of uncertainty around the mean net-to-gross ratio of .57. This was accomplished by the following method. First, the raw, premise-level net-to-gross probability was multiplied by the case weight and the avoided cost weight associated with the premise. This product incorporates the premise level self-reported probability and the weighting factors. Therefore, the variance of this distribution reflects those factors as well, and it represents the uncertainty around the weighted net-to-gross ratio. Quite literally, it is the standard error of the individually weighted distribution of net-to-gross probabilities. This standard error was then multiplied by 1.65, representing 90 percent confidence, to produce a confidence interval of 2987 around the mean of 6859. This confidence interval was then taken as a percent of the mean, or 43.5 percent. To apply this information to the 0 - 1 scale required of the net-to-gross ratio, the uncertainty interval around the .57 net-to-gross ratio was calculated as 43.5 percent of that mean, or .248. Thus, the interval of .248 was subtracted from and added to the .57 mean, to yield an uncertainty range of .32 - .82.

B. Billing Regression Analysis of NTG Ratio

The analysis proceeded based on decisions described in the Section IX. An outline of these decisions will be reviewed here for convenience before discussing the alternatives tested.

A change model was selected for this analysis. In this model the dependent variable is savings, and the independent variables are change-related variables. There are several methods of focusing on change in a modeling effort. One is simply to subtract the mean consumption for the post-installation period from the mean consumption over the pre-installation period. A second method is to produce deltas between pre and post consumption monthly means (using only comparable months in the subtractions) and take a mean of the monthly deltas, taking that as the dependent variable. A third is to predict the change as a percent of the pre-installation consumption mean. This can take the form of subtracting the natural log of the post from the natural log of the pre-installation consumption, or it can take the form of subtracting post from pre and dividing by pre-installation consumption. A fourth approach is to predict the post-installation consumption with a set of independent variables that includes the pre-installation mean consumption as well as change-related variables. In this approach, the change-related variables would predict the residuals resulting when predicting the post consumption by pre consumption, which is equivalent to the difference between the pre and post mean. All but the first method were employed in this study. That method was omitted because it was not based on comparable months.

We chose to separately model energy-using equipment and non-energy-using equipment. The rationale for this is that rated energy-using equipment installed by participants should be compared to similar equipment installed by program non-participants, some portion of which might also be energy-efficient. Installers of non-energy-using equipment installed within the program should be compared to a general population of non-participants, essentially all of whom could have installed some non-energy-using equipment, with or without the help of a rebate. Recall that all interviewed customers had air conditioning equipment of some kind in their buildings. It is also important to note that the decision to estimate models on these two separate groups has implications for sample size and variances. This is true because the sample on which each model is estimated will be divided into two smaller parts (Refer to Chapter IX for a full description of the rationale for this decision).

The categories of variables measured/collected to explain savings were all (with one exception) change-based and all would be expected to have an impact on the change in consumption over time. Six groups of variables were involved:

1. Weather differences
2. Macro-economic trends
3. Changes in business hours
4. Changes in square footage
5. Equipment installed without rebates (self reported)
6. Equipment rebated by other programs (1992,93/95 HVAC, 1992-95 Lighting, data taken from the tracking system)

Building types were also considered important, in spite of being constant over time, because they can represent unobserved trends in some segments of the economy that may not apply to all.

Modeling Goals

The goals in the search for the best model were to find a set of predictors:

1. with coefficients stable enough to apply to both energy-using and non-energy-using models
2. with plausible coefficients both in terms of size and sign
3. that pass diagnostic tests for influential observations, heteroskedasticity, and collinearity
4. that include all categories of variables that are expected, *a priori*, to belong in the model.

The Final Model

The final model, without correction for selectivity, is shown in Table XII-2. The same variables are included for both equipment groups. The final model was selected *before* applying Mills ratios for correction of selectivity biases. The reasoning behind this approach was that the variables that best predict consumption behavior in the most stable and consistent manner should be established first before addressing higher-order issues. Then the measures of self-selection biases should be applied to the model and their effects on the model determined. The variables included in the final model, together with their coefficients are listed in Table XII-2. This model has the following characteristics. First, the dependent variable is the direct mean of the monthly pre/post deltas using comparable months. This dependent variable, in combination with the explanatory variables chosen, produces a model that allows the same specification to be used for both equipment groups. That is, the variables remain the same and, with one exception (Change in business hours in the non-energy-using model), the signs of the coefficients are appropriate and remain the same (ignoring the building type signs, for which we have no directional expectations). Further, the magnitudes of the coefficients are plausible and it is possible to understand why they are operating as they do.

The selection of the direct monthly delta dependent variable requires that some time be spent in describing the interpretation of the coefficient signs. This interpretation is complicated by the fact that the explanatory variables are also change oriented, so the interpretation has to take into account the effect of the *change* in the independent variable on the *change* in the dependent variable. It is important to remember that the post period kWh value is always subtracted from the pre-period value. Thus, a decrease in consumption will result in a *positive* delta, or a positive savings. Both weather and economic data were treated the same way: post values were subtracted from pre, with the pivot point defining the two time periods being the same as that used for consumption. Therefore, a decrease in employment between the pre-installation and post-installation periods would result in a positive delta just as it would for the consumption data. Since we would expect less consumption during periods of less employment, we would expect a positive correlation between employment change and consumption change. This is intuitively apparent. It is more complex, however, for the other change variables.

An example of a more complex type of change variable is square footage. When a value was calculated for a change in square footage, it had to be handled differently than consumption or weather or economic variables because the change could happen at any time during the pre-installation or the post-installation period and its effects would continue from that time forward. The change itself was created to have a negative sign for a decrease and a positive sign for an increase in square footage. This signed magnitude was then multiplied by the fraction of relevant time before or after the installation pivot point. Therefore, the sign of the value for a given observation will reflect the direction of the change and the magnitude will reflect the relevant proportion of time it was in effect. A decrease in square footage will be negatively correlated with a decrease in consumption as reflected by the *positive* delta. The same is true for the variables standing for changes in business hours. Because of the complexities of these interpretations, the expected signs are provided in Table XII-2 for convenience.

Table XII-2: Final Models Before Correction for Selectivity

		Energy-Using		**Non-Energy-Using**	
Variable	**Expected Sign**	**Parameter Estimate**	**T Prob**	**Parameter Estimate**	**T Prob**
INTERCEP		980	0.82	385	0.8
Program Participation	+	2608	0.56	3909	0.03
Pre minus post heating degree days	+	58	0.66	48	0.64
Change in business hours	-	6.6	0.98	42	0.87
Change in square footage	-	-2.1	0.02	-1.3	0.0001
Self-reported HVAC install	+/-	-8490	0.06	-5859	0.28
Pre minus post employment rates	+	410	0.62	875	0.06
Office building	+/-	-1549	0.56	3434	0.04
Restaurant	+/-	-1497	0.74	15	0.99
Large or small retail	+/-	2017	0.62	1594	0.51
Food store	+/-	724	0.91	3618	0.5
Warehouse	+/-	-2868	0.59	-2134	0.54
Primary/secondary schools	+/-	-211	0.95	-348	0.93
Clinics	+/-	368	0.94	-1019	0.82
Hotel or Motel	+/-	926	0.9	-1740	0.71
Personal repair services	+/-	-2289	0.75	107	0.97
Community Services	+/-	510	0.9	-1844	0.47
N (Total)		**169**		**740**	
Participants		138		298	
Nonparticipants		31		442	
R^2		**0.07**		**0.17**	

Special mention should be made of the "Self-Reported HVAC Install" variable. This is a dummy variable that is coded 1 if any type of equipment was installed within the period under consideration. It was based on a more complex series of variables calculated in a way similar to the square footage and business hours variables. However, because the extra-program installations were so sparse, they were combined into this dummy variable. The equipment for which information was elicited was HVAC-related. This could mean energy-using or non-energy-using technologies. It could represent additions or replacements. Thus, it is difficult to predict which sign the coefficient would take on. In the models estimated, it consistently takes a negative sign. Given the sign, it seems likely that it is measuring those premises that have been increasing their energy-using activities, and these activities have included installing equipment. The negative sign indicates that those who installed self-reported, non-rebated equipment have smaller pre-post decreases in consumption, i.e., they don't save as much or they increase their usage. The consistency of the sign would seem to indicate that it is capturing *some* relevant phenomenon.

Variations on this model were estimated by substituting alternative measures in each category. For example, several measures of economic trends were available. Each of these were tried within the context of the other variables in the model to determine which performed more appropriately and consistently. Another example is the variable representing changes in business hours. This concept was measured and calculated in several ways. Each change in hours was recorded, including the direction and magnitude of the change. The changes were calculated for the pre-installation period and for the post-installation period; they were also divided into two variables, one indicating increases and another indicating decreases; these alternatives were tried in succession to find the best form. The same measurement and calculation pattern characterized the changes in square footages, although there were fewer such changes compared to business hours. Alternative forms of each of the variables were systematically varied to determine the consistency of the performance of each across the models for the two equipment types. Building types were not subject to alternative measurements.

Alternative forms of the dependent variable were also tested systematically. It quickly became apparent that any form of change measurement that was based on change as a percentage of pre-installation consumption could not be useful for the non-energy-using model. This is because a group of smaller customers in that model experienced negative savings (i.e., increases in consumption), and these changes constituted a large percentage of their average pre-installation monthly consumption. It is likely that these customers experienced changes in their operations that resulted in increases in consumption. Some of these types of changes were measured (addition of square footage, addition of energy-using equipment) but there are likely other, unobserved factors at work as well. The smaller the customer is, the larger the percentage any change will represent. Very large customers can make large changes but they will still represent only a small percentage of their total consumption. These factors produce a situation where smaller business behavior dominates the model because the percentages will be larger for them. An examination of the distribution of percentage changes in consumption in this data set shows that the negative changes tend to be larger (in percentage terms) than the positive changes. Thus, percentage-based measure of change produced consistently negative values. This makes the use of such models impractical.

Because of these problems with the percent change measures, only two versions of the dependent variable were viable alternatives. The first is the mean of the direct deltas between comparable months pre and post-installation. The second is the residuals resulting from regression of post-installation mean consumption on pre-installation mean consumption. The former is more intuitively appealing because it involves studying directly the phenomenon that we are interested in: change in consumption. The latter is appealing because it produces very good-fitting models, as measured by R^2.

The method of regressing post on pre-installation consumption was ultimately rejected as the final method because the pre-installation consumption variable tended to have a coefficient of about .94 in the non-energy-using model when it should have been one. The fact that it was lower than one meant that the independent variables would be attempting to explain more than just pre to post change; they would be explaining change plus some other unknown factor. This problem was reflected in inconsistencies in the parameter estimates. In particular, the savings parameter took on an implausibly low value in the non-energy-using model. It took on a higher value in the energy-using model, and the difference in savings estimates between the post-on-pre-installation method (regressing post on pre-installation consumption) versus the direct difference method was not unreasonable for the energy-using equipment model. However, because a high priority was placed on finding a model that had the same specification across the two equipment groups, the direct difference method was selected for final processing.

The savings estimated by this model which does not correct for selectivity is simply the value of the parameter estimate for the participation dummy, the variable labeled "Program Participant" in Table XII-2. For premises with energy-using efficiency measures the mean monthly savings per premise is 2608 kWh, for premises with non-energy using measures the mean monthly savings per premise is 3909.

Table XII-2 presents two central pieces of information about each term in the model: the parameter estimate, and the probability associated with the estimate. The parameter estimate can be interpreted as the amount of kWh change that is associated with a one-unit change in the independent variable involved. The probability of T for that variable indicates the probability that a parameter estimate that large or larger could have been obtained by chance factors alone, given the variation around that estimate. A large probability reflects a large variance relative to the (mean) parameter estimate. The larger the variance around the mean estimate, the less certainty we have in the estimate. A probability of .05 is commonly taken to indicate statistical significance, although this value is arbitrary. It will be noted that few of the parameters of either model meet the traditional significance criterion. Statistical significance was not a high-priority criterion for inclusion in the model. Consistency and plausibility of performance of the parameters was a higher priority.

Correcting for Selectivity Bias

Without correcting for selectivity bias, the model shows that the average monthly net savings for premises installing energy-using equipment would be 2608 kWh. The analogous savings estimate for premises that installed non-energy-using equipment would be 3909 kWh. However, it is important to take account of the fact that participants and non-participants are not randomly assigned to those categories. Different businesses may be differently exposed to the program and may be differently inclined to participate. Traditionally, an inverse Mills ratio is included in the model to account for the relation between naturally occurring savings and participation. A second inverse Mills ratio is entered for participants to account for the relation between *net* savings and participation. When the two inverse Mills ratios are added to the models for energy-using and non-energy-using equipment, the same pattern emerges in each model. In particular, the first inverse Mills ratio enters with a positive sign in each model. This indicates that naturally occurring savings is positively correlated with participation. Stated equivalently, a customer who would have a tendency to take measures even without the program (that is, customers who are naturally inclined toward conservation) tend to take measures on their own.

The second inverse Mills ratio enters with a negative sign in each model. This result implies that net savings is negatively correlated with participation. In a sense, the estimated relation between net savings and participation is the expected consequence of the estimated relation between naturally occurring savings and participation. Customers who would have taken the measures even without the program have high naturally occurring savings; the positive coefficient of the first inverse Mills ratio implies that these customers tend to participate in the program more readily. Since these customers would have taken the measures with the program, their net savings are generally low; the fact that they participate in the program more readily means that the net savings is negatively correlated with participation--as implied by the negative coefficient on the second inverse Mills ratio. The inverse Mills ratio therefore enters the two models in a consistent and highly plausible manner.

Table XII-3: Models After Correction for Selectivity

		Energy Using		Non-Energy Using	
		Parameter		Parameter	
Variable	**Expected**	**Estimate**	**T Prob**	**Estimate**	**T Prob**

	Sign				
INTERCEP		2154	0.9	845	0.86
Program Participation	+	8438	0.62	7618	.19
Pre minus post heating degree days	+	64	0.63	59	0.56
Change in business hours	-	-74	0.78	43	0.87
Change in square footage	-	-2.7	0.007	-1.3	0.0001
Self-reported HVAC install	-	-12924	0.014	-7014	0.2
Pre minus post employment rates	+	344	0.68	845	0.08
Office building	+/-	-2604	0.34	3359	0.04
Restaurant	+/-	-830	0.85	191	0.95
Large or small retail	+/-	881	0.83	1561	0.52
Food Store	+/-	774	0.9	3787	0.49
Warehouse	+/-	-2798	0.6	-1745	0.62
Primary/secondary schools	+/-	-1853	0.61	-882	0.82
Clinics	+/-	178	0.97	-1355	0.76
Hotel or Motel	+/-	1767	0.81	-1293	0.78
Personal repair services	+/-	-1069	0.88	68	0.98
Community services	+/-	2106	0.62	-2132	0.41
Inverse Mills ratio-all premises		744	0.95	330	0.92
Inverse Mills ratio for participants		-5884	0.63	-3762	0.38
N (Total)		**169**		**740**	
Participants		138		298	
Nonparticipants		31		442	
R^2		**0.09**		**0.18**	

Creation of Inverse Mills Ratios

The equation for calculating the inverse Mills ratio, as used in this study, was presented in Chapter IX. This equation was based on the predicted probability of participation, which, in turn was based on the results of a probit model. The probit model was the result of a specification search among variables that were believed to be theoretically relevant to participation. The results of this model are shown in Table XII-4. Using the model, we were able to predict the participation status for nearly 70% of the 880 participants and non-participants. The predicted probabilities of participation from this model were then used in equations 1 and 2 in Chapter IX to create Mills ratios for participants and non-participants respectively.

Table XII-4: Participation Model for Producing Probabilities that are Inputs for Inverse Mills Ratio

Independent Variable	Estimated Coefficient	Standard Error	t-Statistic	Sig
Mean cooling degree days in pre-period	.0257	.000794	3.23	***

Installed HVAC outside program	1.35662	.89953	1.508	
Mean kWh pre-period	.00000017	.000000216	.789	
Respondent owns building	-.2548	.0699	-3.645	***
Weekly business hours	-.0025	.00112	-2.25	**
Changes in business hours pre	.0384	.0294	1.306	
Received audit	1.23597	.14087	8.77389	***
Total lighting installed	1.20741	.26693	4.52339	***
Building separately metered	-.0453	.11402	-.397	
Mean heating degree days	-.017	.00198	-8.55742	***
Cooled square footage	.00000115	.000000859	1.33717	
Changes in square footage-pre	.00109	.000518	2.1091	**
Respondent pays electric bill	-.28184	.16285	-1.73074	*
Auxiliary Statistics	**At Convergence**	**Initial**		
Log Likelihood	-481.97	-609.97		
Number of Observations	880			
Percent Correctly Predicted	69.886			

***Probability of .02 or less, **Probability of .05 or less, *Probability of .1 or less

Alternatives Tested

Following is a description of some alternatives tested, the decisions made, and the reasons for them.

Building Types. The effect of building type variables in the model were tested by removing them. Removing them decreased the overall fit of the model and reduced the t-statistic for the participation variable. These improvements were relatively small; however, no serious consideration was given to leaving them out of the model because they were felt to capture more than could be measured otherwise. Building type designations capture activities that are occurring differentially in different segments of the economy. Since there were no *a priori* expectations about the direction of the effects of specific building types, the signs of their coefficients did not enter into the decision.

Macro-Economic Variables. The original model employed aggregated consumption by segment and climate zone as a measure of macro-economic trends. The major alternative to that that was considered was the employment level in the commercial segments of the economy. The decision was made to remove the aggregated consumption variable in favor of employment figures which form a more straightforward measure of economic conditions. The latter increased the magnitude of the coefficient and improved the t-statistic to significance in the non-energy-using model, but made only a slight improvement in the energy-using model. It may be that the aggregated consumption variable incorporates too many trends, thus masking their individual effects. Recall that the variable includes not only consumption but climate zone as well.

Weather Variables. The cooling degree day change variable entered the initial model with the wrong sign in the energy-using model. For this reason it was removed to test its impact. Removing it had very little effect on the model. On this basis it was not retained. Maintaining correct signs and plausible magnitudes were important standards against which alternatives were judged. It is somewhat counterintuitive that the heating degree days variable would perform better than cooling degree days;

nevertheless, it is apparently empirically true that the heating degree day variable captures the weather effect in a consistent way, across both models, whereas the cooling degree days variable does not. In an effort to understand why the cooling degree day change performed so inconsistently, zero-order correlations between monthly mean cooling degree days, heating degree days, and monthly mean kWh (all in their non-change form) were performed. This simple analysis revealed that the cooling degree days were negatively related to consumption. This was true in both equipment type data sets as well as the total sample. Heating degree days, on the other hand, behaved appropriately. This pattern is certainly at the base of the problems the cooling degree day change variable had in the models.

The Protocols require that savings be estimated using normalized weather. In a change model, however, this is not possible. Weather variables (as most others in the model) are developed by subtracting post-installation values from pre, using comparable months. If normalized weather were used, this subtraction would result in values of 0 for all weather. Therefore, actual weather values were used in this model.

Installations Rebated Under Other Programs. Two types of extra-program installations were available to the model. Self-reported installations entered in an appropriate way. The addition of the other program installations proved less beneficial. A pair of variables was entered, one for energy-using equipment and another for non-energy-using equipment installations within another program year. The variables increase the participant savings estimate; they entered with opposite signs in the two models, their entry changed the sign of the self-reported installations in the non-energy-using model, and increased the magnitude of the self-reported installation coefficient to an implausible level in the energy-using model. In other words, their performance is very unstable. Investigation into the distribution of the two variables reveals clues as to why they behave in this way. First, rebated installations outside the 1994 HVAC program were sparse even among participants. No nonparticipants in the energy-using model made any such installations, and very few did so in the non-energy-using model. Participants in the energy-using model, when they did install, tended to do so in the pre-program period. Participants in the non-energy-using model tended to spread their installations more evenly between pre and post periods. In short, the two samples behaved differently, but, more basically, there were too few such installations to expect consistent performance. Therefore, these variables were not retained in the model.

Diagnostics

Diagnostic tests were performed in three areas: outliers or influential observations, collinearity, and heteroskedasticity. Following were the results.

Influential Observations. Two influential observations were detected in the energy-using model. One showed a DFITTS value of 31 and the other a value of 10 (see Chapter IX for a description of DFITTS). As an indication of the strength of these figures, the next largest DFITTS value was 1.6. Each of the two problem observations was removed from the analysis, one at a time. The removal of each produced a very strong impact on the coefficients in the model, especially the participation coefficient. With both of the observations removed, the performance of the model became much more reasonable and stable. That is, the signs were appropriate, the magnitudes were plausible, the R^2 doubled, indicating a better overall fit, and the two models behaved in parallel. Closer inspection indicated that one of the businesses identified reported an increase in square footage of 58,000 ft., and the other had a pre-installation kWh consumption of 15,000,000 kWh. These facts would not, in themselves, necessarily indicate removal. They only help to explain the *important* fact which is that their data as a whole, did not behave according to the patterns established by the rest of the observations in the model.

Two observations within the non-energy-using models produced DFITTS values of over 2. However, when removed, the parameters maintained their signs, remained at approximately the same magnitudes, and the R^2 actually decreased substantially. Since these observations did not change the behavior of the parameters, they were retained. In their cases, the extreme values related to other variables in the model in a way similar to other observations with less extreme values. In this situation the large values added beneficial variance to the model.

Heteroskedasticity. The first step taken toward detecting heteroskedasticity was to plot the predicted values from the model against the residuals. Visual inspection of these plots for the energy-using model showed no evidence of the typical fan form of heteroskedasticity, nor any other identifiable pattern. Within the non-energy-using model, the predicted value for one case was so extreme that the remaining cases were clustered together at the other end of the graph and no patterns could be observed. This case was removed so that the rest could be re-plotted and observed. The remaining cases formed no recognizable pattern. The case with the extreme predicted value was revealed to be one that was identified in the outlier analysis but retained in the model. As was implied by the description above, although extreme in predicted value, the observation was very close to zero on the residual axis.

A further search was conducted toward identifying heteroskedasticity by regressing the variables in the model on the standardized squared residuals (the Breusch/Pagan test). The F-statistic was not significant, and only one variable showed a significant t-statistic. As a result of these two tests, it was concluded that no serious heteroskedasticity was present in the data.

Multicollinearity. Before any models were estimated, the correlation matrices for the two data sets (energy-using and non-energy-using) were examined for high correlations. None was high enough to generate concern, although the building types showed some intercorrelations, the largest magnitude being .77. However, inspection of zero-order correlations may not reveal collinearities that are generated by multiple-variable combinations. For this purpose, an analysis of the matrix structure was performed, with the eigenvalues and condition numbers used as indicators. In these analyses of both models, no eigenvalues approached zero, and no condition numbers approached 30, a commonly-used value for discriminating problem levels of collinearity. Thus, it was concluded that there were no such problems in these models. Special attention was paid to the cooling degree days and heating degree days variables as the former was suspect based on its unstable performance in the models. However, they were not implicated by this analysis.

Sensitivity Analysis

The dependent variable chosen for the primary estimate of net savings for the two equipment groups was the mean of monthly differences between pre-installation and post-installation consumption, subtracting post months from pre, using comparable months. The only way to retain 12 consecutive months of consumption in the analysis using this method, was to include the installation month in either the pre or the post period. We chose to include it in the post period. However, it was considered important to test the results for sensitivity to this decision. This is because it is clear that most installations will not have been installed within a day, and the day will not always be conveniently placed at the end or beginning of a month. Therefore, there is certain to be error in the placement of the dividing line between pre and post consumption. Further, there is reason to believe that the installation actually occurred before the pivot date used. For this reason, a re-estimation of the final model was carried out on the same data sets, but with deadbands on the installation month, the month before, and the corresponding months that would have been compared to those two. In other words, if a business installed an EMS in January, 1994, that month will be deadbanded, as well as December, 1993. Because January, 1994 is deadbanded, January, 1993 must be eliminated as well in order to retain comparable months. The same is true of December, 1994, because it would have been compared to December, 1993 in the primary analysis. This procedure is likely to have excluded most of the time that is in doubt as to its pre versus post status.

The results of this re-estimation are portrayed in Table XII-5. The results of this model are reassuring. There are no sign changes (compared to the primary analysis) in the energy-using model, and only one in the non-energy-using model (aside from a building type change). The magnitudes of the coefficients are quite similar. The estimated net savings resulting from the energy-using model are slightly smaller than in the primary model, 1169 kWh, while the savings estimated by the non-energy-using model was a little larger at 4170 kWh. This result gives us some confidence in the stability of the model, and in the decisions on the pre/post pivot point. We were able to estimate a stable model while meeting the Protocol requirement of 12 months of consecutive pre-installation billing data.

Table XII-5: Model Results Deadbanding Two Months

		Energy-Using		Non-Energy-Using	
Variable	**Expected Sign**	**Parameter Estimate**	**T Prob**	**Parameter Estimate**	**T Prob**
INTERCEP		2380	0.89	241	0.96
Program Participation	+	8390	0.65	8693	0.16
Pre minus post heating degree days	+	25	0.68	-25	0.66
Change in business hours	-	-95	0.75	44	0.87
Change in square footage	-	-2.8	0.008	-1.4	0.0001
Self-reported HVAC install	-	-14604	0.01	-7936	0.16
Pre minus post employment rates	+	359	0.69	970	0.04
Office building	+/-	-2905	0.33	3554	0.05
Restaurant	+/-	-677	0.89	323	0.91
Large or small retail	+/-	160	0.97	1586	0.52
Food store	+/-	1991	0.76	3555	0.52
Warehouse	+/-	-2569	0.66	-1692	0.64
Primary/secondary schools	+/-	-1891	0.64	-1233	0.76
Clinics	+/-	470	0.93	-1242	0.79
Hotel or Motel	+/-	1425	0.86	-977	0.84
Personal repair services	+/-	-860	0.91	-41	0.99
Community Services	+/-	1911	0.68	-2218	0.4
Inverse Mills ratio-all premises		972	0.94	177	0.96
Inverse Mills ratio for participants		-6333	0.64	-3832	0.38
R^2		**0.09**		**0.19**	

Net KWh Savings

Having settled on the model shown in Table XII-2, and on the method of correcting for selectivity as shown in Table XII-3, the next step in the process was to calculate average, premise-level net savings. First we multiply the "Inverse Mills ratio for participants" parameter estimate by the mean value of that variable. This product is added to the parameter estimate for the participation dummy ("Program Participation"). For the energy-using model, this translates to: 8438+(-5884*1.136) which provides an estimated net savings of 1754 kWh per month. The model for non-energy-using equipment provides an estimated savings of 3171 kWh per month, 7618+(-3762*1.182). The selectivity corrected estimate for energy-using equipment savings is 854 kWh or 33 percent lower than the uncorrected estimate. The corrected estimate for non-energy-using equipment is 738 kWh or 19 percent lower than the uncorrected estimate. These figures are plausible and within a reasonable range of each other, lending credence to this adjustment method. Further indication that the double Mills method is working appropriately is the fact that the model with the ratios fits better than without, as measured by the R^2 .

Results from both the energy-using measure model and the non-energy-using measure model contribute to the calculation of the overall NTG ratio derived with this billing regression methodology. Table XII-6 below show the relative contributions of each model to this ratio.

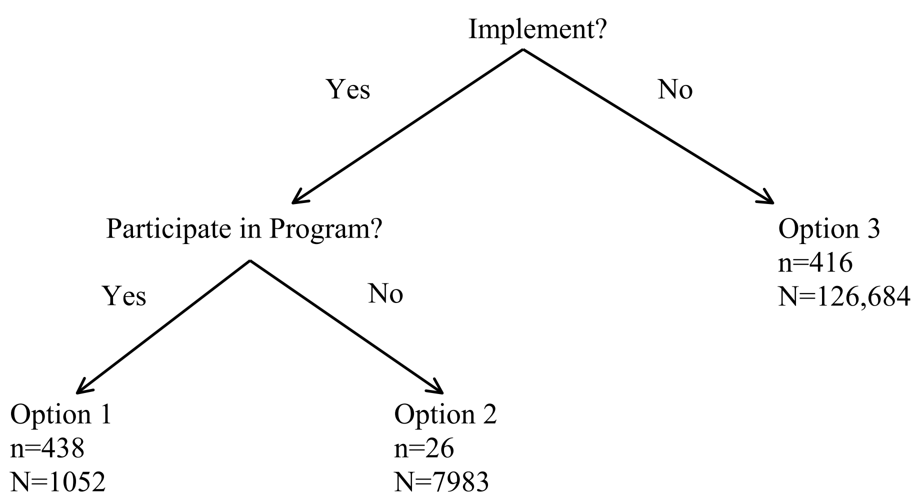
Table XII-6: Contribution of Energy Using and Non-Using Models to NTG Ratio

	Savings Estimate (GWh/year)			**Net**	
Category	PG&E Gross	PG&E Net	Evaluation Net	**Realization Rate**	**Net-to-Gross Ratio**
Energy-Using Measures	33.0	23.1	16.3	0.71	n/a
Non-Energy Using Measures	32.1	23.4	22.7	0.97	n/a
AGGREGATE	**65.1**	**46.5**	**41.9**	**0.90**	**0.70**

C. Discrete-Choice Analysis of NTG Ratio

Using the methods describe in Section VIII, we estimated the net-to-gross ratio using discrete choice analysis. The unit of analysis is the premise and the available data are described in the data dictionary in Chapter VIII. Figure XII-1 illustrates the customer choices which are modeled and shows the number of premises choosing each option.

Figure XII-1: Three Customer Choices



Using the numbers shown in Figure XII-1 in this raw form suggests an "apparent" net-to-gross ratio of .93. The question is the extent to which this "apparent" ratio will be modified by the statistical analysis.

Signs of Coefficients

A coefficient is estimated for each explanatory variable in the participation and implementation models. A positive coefficient indicates that a given factor increases the probability that a customer is a participant or that the customer implements an efficient measure. A negative sign indicates the opposite.

Criteria

We relied on three rules for retaining a variable or group of variables in the model:

1. A single variable added to the model must be significant at the .10 level.
2. A group of variables added to the model must improve the log likelihood beyond the more restrictive model at the .10 level of significance.
3. There must be a theoretical reason for including the variable.

The final product of this modeling effort is to estimate a net-to-gross ratio. If, after estimating the implementation model which includes the LS variable produced by the participation model, the net-to-gross ratio is implausible, then each of the two models must be revisited in order to understand better the source of the implausibility. Thus, the subsequent plausibility of the net-to-gross ratio became a fourth criterion in selecting variables for the final model.

Following are the specific steps taken in the analysis.

Step One: Results of the Participation Model

We began by estimating weighted logit models with just the constant. We then systematically entered theoretically relevant variables one at a time. If the resulting t statistic was significant at the .10 level then the variable was provisionally retained in the model. After entering relevant variables one at a time, we tried entering groups of variables and calculating the Log Likelihood Ratio Test (LRT). If the LRT exceeded the critical values of chi-square at the .10 level, then the variables were provisionally retained in the model.

Using these procedures and criteria, none of the variables could be retained; only the intercept was statistically significant in the first specification. The correlation matrices were examined to detect any collinearity problems among the variables chosen for inclusion. Correlations appeared to be below the threshold normally associated with collinearity (i.e., they were less than .70). The more likely explanation of the problem in finding significant t statistics is that there is too little variance to explain. This is suggested by Figure XII-1 which shows that the shares of participating implementors and non-participating implementors are 94% and 6% respectively.

Another factor operating in this model is that the calculated weights (see Appendix H) are rather extreme and seemed to affect adversely the calculation of standard errors. To eliminate this problem, the models were estimated on unweighted data, with the expectation that the intercept would be adjusted in a later step to produce the results that would have come out of a weighted model. This method allowed decisions to be made based on criteria not influenced by possible weighting distortions. However, the problem of small t statistics remained, although to a somewhat lesser degree, suggesting that low variation in the dependent variable is likely to be the source of the problem.

In spite of learning that the low t statistics were not due (entirely) to the extreme weights, model estimation continued based on unweighted data with adjustments to the intercepts. Table XII-6 shows the final model.

Table XII-7: Participation Model

Independent Variable	Estimated Coefficient	Standard Error	t Statistic	Sig
Intercept	1.813	.389	4.659	***
Separately Metered	.788	.422	1.866	*
Who Manages Building	.762	.408	1.869	*
Auxiliary Statistic	**At Convergence**	**Initial**		
Log Likelihood	-96.662	-321.62		
Number of Observations	464			
Percent Correctly Predicted	94.397			

***Probability less than .02, *probability less than .1

As indicated above, only the intercept is significant at or beyond the .05 level. The other two variables, whether a customer's premise is separately metered and whether the respondent's company or firm manages the building, had t statistics that were significant at the .10 level. Both of these variables have positive signs, indicating that a positive value on the independent variable increased the probability of a customer participating. The one-by-one inclusion of each of the other available variables resulted in virtually no statistically significant t statistics. Those that were marginally significant were (in a subsequent step) implicated in producing an implausibly high or low NTG ratio. It should also be noted that the "percentage correctly predicted" is guaranteed to be fairly high, and will be *very* high if the d.v. is skewed. Thus, in the participation model, this percentage, while reported, is not used in evaluating the performance of this model.

Next, the intercept was scaled by adding -5.0 in order to match the *estimate* of the proportion of participating premises in the population that implemented rebate-eligible measures and obtained rebates to the *actual* proportion in the population. This ratio for the participation model is .116 (see Appendix H for a more complete discussion of these weights).

Once the coefficients in the participation model are estimated using participant and non-participant implementors, these coefficients are used to calculate the log sum (LS) variable for *all* participants and nonparticipants not just those who implemented an efficient measure. We are in effect generalizing these effects contained in the estimated coefficients to the non-participant non-implementors. The log sum variable reflects the similarity or dissimilarity between options 1 and 2 as perceived by both participants and nonparticipants. These perceptions will affect their decision to implement. Once calculated, the LS is then included in the implementation model.

Step Two: Implementation Model

Step two involves estimating the implementation model. Table XII-7 displays the final model. All of the parameters except one are significant at least at the .05 level and in combination result in a significant overall improvement over the restricted model. The one exception is the building management variable. It was included because, although it is not statistically significant at the specified level, its exclusion leads to a net-to-gross ratio of 2.78 which violates the plausibility criterion. As defined, each of the variables, except two, increase the probability of implementation. If the respondent's building was built after 1979 and if efficiency measures were installed in 1992 and 1993 without a rebate, then the chances of that premise implementing an efficiency measure in 1994 decreased.

The next step was to scale the constant by -3.1 to match the *estimate* of the proportion of premises in the population that implemented rebate-eligible measures to all premises in the population that implement. This ratio is .067 (see Appendix H for a more complete discussion of these weights).

Calculation of the net-to-gross ratio

Using the results of the participation and implementation models, the net-to-gross ratio was calculated using the approach outlined in Section VIII. The result was a net-to-gross ratio of .55. The 80% confidence interval is +/- .248 while the 90% confidence interval is +/- .319.

Sensitivity Analysis

To determine how sensitive this result is, a large number of other specifications were modeled. This exercise makes it very clear that the NTG ratio is very sensitive to changes in both the participation and the implementation models. The magnitude of the LS variable changes when one changes the specification of the participation model. This change reverberates throughout the implementation model in ways that are often dramatic and unpredictable. In addition, within the implementation model, some collinearity was observed between some of the independent variables and the LS variable.[1] For example, in the selected model, the building management variable is correlated at .79 with the LS variable. When this variable is removed, the NTG increases to 2.78, an implausible level. In this particular case, the presence of the building management variable appears to dampen the coefficient on the LS variable thus producing a more plausible, although very conservative, NTG ratio of .55. Changing other variables, even those not strongly correlated with LS, also produced dramatic changes in the NTG ratio. We suspect that this is caused by even more complex forms of collinearity that could not be detected involving combinations of variables. Below are listed examples of the effects of removing and adding various variables and their effect on the NTG ratio.

Table XII-8: Implementation Model

Independent Variable	**Estimated Coefficient**	**Standard Error**	**t-Statistic**	**Sig**
Intercept	-1.154	.299	-3.856	***
Log Sum	.634	2.474	.256	
Who Manages Building	.423	.259	1.633	
Built Before 1979	-.759	.171	-4.448	***
Percent of Wall that is Glass	.009	.004	2.407	***
CD in Pre Period	.005	.001`	3.838	***
Office	.829	.181	4.576	***
Rebates in 1992-1993	1.436	.228	6.293	***
Install Without Rebates in 1992-1993	-.224	.090	-2.498	***
School	1.724	.319	5.398	***
Warehouse	1.198	.358	3.349	***
Hotel/Motel	1.512	.457	3.312	***
Community Service	.814	.260	3.131	***
Auxiliary Statistics	**At Convergence**	**Initial**		

[1] Collinearity among the other independent variables was not a serious problem.

Log Likelihood	-518.52	-609.97
Number of Observations	880	
Percent Correctly Predicted	68.295	

*** Probability less than .02

- Including the 1992-93 PG&E rebate variable in the participation model decreases the net-to-gross ratio to .06.
- Including the 1992-93 PG&E rebate variable in the participation model and removing the building management variable increases the net-to-gross ratio to 1.76.
- Including the 1992-93 PG&E rebate variable in the participation model and replacing the building management variable with the retail business dummy variable increases the net-to-gross ratio to 1.96.
- Including the 1992-93 PG&E rebate variable in the participation model and adding the food business dummy variable in the implementation model reduces the net-to-gross ratio to a negative 1.03.

Other specifications and the resulting net-to-gross ratios have been included in Appendix G. These models, although having remarkably similar specifications, produced very different net-to-gross ratios.

Interpretation of the results

There are two points worth mentioning in interpreting these results. First, a net-to-gross ratio of .55 is in the plausible range, although it would seem to be at the conservative end of that range, given the "apparent" net-to-gross ratio of .94 introduced earlier. In fact, it is probably at the very conservative end of that range, given the results of the billing regression analysis and past evaluations of this program. That this net-to-gross ratio is conservative is underscored by the fact that spillover cannot be taken into account with the discrete choice approach used here.

Second, as we've mentioned, both models have problems that reduce our confidence in these results. The participation model is difficult to specify owning to a very skewed distribution of the dependent variable. This in turn makes it difficult to accurately estimate the critical LS variable. This model is also sensitive to specification changes with small changes in the specification of the participation model producing important changes in the LS variable. The implementation model is very sensitive to changes in specification and the resulting range of possible net-to-gross ratios is quite large. This appears to be due to both simple and more complex forms of collinearity.

Recommendations Regarding Data Collection

We have concluded that one of the main problems with our participation model is the fact that only 26 non-participants were available for the participation model. We suspect that the primary reason for this is that non-participant installations of efficient equipment may have been somewhat underrepresented due to non-response and measurement error. We were able to obtain enough information to determine the efficiency of the cooling equipment for only 19 of 32 non-participants and of these 19 only two premises had installed equipment for which they could have received a rebate. In addition, we are not now entirely certain that respondents always knew whether they had installed some of the other non-energy using equipment such as EMSs or timeclocks. To the extent that the installations of efficient equipment among the nonparticipants was underestimated due to non-response and misreporting, the size of the non-participant sample of implementors available for the participation model was smaller than it could have been. A larger group of installing non-participants would increase the variance of the dependent variable (participant installer versus non-participant installer) in turn increasing the chances of obtaining significant t-statistics. This in turn would help in correctly specifying the model.

What this suggests is that data collection must be approached in a different manner. First, it is possible that interviewers who are more familiar with the equipment could have elicited more accurate information from the respondents. Perhaps engineers who have interviewing experience could conduct the interviews and collect better information. It also seems that some on-site surveys must always be part of any data collection effort among the non-participants in order to minimize the problem of item non-response and measurement error. If better information cannot be collected, then other techniques should be considered for estimating net-to-gross ratios.

D. Investigation of Spillover Effects

Although this study was not specifically designed to detect program spillover effects, we explored what data were available to attempt to identify potential spillover effects. Such effects could be found among participants in the 1994 retrofit program, or among non-participants. Of course, the search for program-influenced, but unrebated energy-efficient installations must be restricted to self-reported installations identified in the interview. Ideally, information would be available about the customer's motivation for the installation to determine the level of influence PG&E had on the decision. This information was not available since this topic was not part of the study design. A further limitation is that we cannot know whether non-rebated air conditioners or other rated equipment is energy efficient. Therefore, we cannot know if the customer was influenced to install energy-efficient equipment. Because of this we focused only on non-energy-using equipment, all of which are inherently energy-saving. Anyone who installs one of these pieces of equipment can reasonably be said to have installed energy-efficient equipment.

With these limitations in mind, we undertook to determine whether those nonparticipants who said they had received an audit were more likely to have installed energy-efficient equipment than those who had not. It was reasoned that, if there is spillover among these nonparticipants it would result in more installations among those who had received PG&E audits than among those who had not. Table XII-8 shows the result of this analysis. It is clear from this table that it would be difficult to make a case for spillover among nonparticipants.

We also examined program participants for evidence of spillover. We reasoned that the participants in this sample were certain to have had more contact with PG&E's programs than non-participants. Therefore, if there were spillover, we would expect to find more non-rebated installations of efficient equipment among participants than non-participants. Table XII-9 reflects the results of that analysis. It shows that participants are a little more likely to have installed non-rebated energy-efficient equipment than non-participants. The standard Chi-squared test shows a probability of .055 to have found observed frequencies as far from expected distributions as that found in this table. The Fischer's Exact test for 2 x 2 tables is more suited to the directional nature of this issue. That is, we expected that the 1,1 cell (participant installers) to show deviation from expectation more than any other cell. The probability of finding a frequency in this cell this high or higher is .035.

The result reported here can be considered suggestive only. There is no way to know the causal direction of the association that is identified in Table XII-9. It may be that the program influenced these customers to install further equipment without further incentive, or it may be that those who install energy-efficient equipment tend to participate in PG&E's programs. It would take more information to determine how much of the association was spillover and how much was selectivity bias. This result is only enough to suggest further investigation into the spillover phenomenon.

Table XII-9: Percent of Non-participants Audited That Installed Non-Rebated Energy-Efficient Equipment

	Received Energy Audit	Did not receive Energy Audit
Did not install energy-efficient equipment	74 90.2%	282 89.8%
Installed energy-efficient equipment	8 9.8%	32 10.2%

Table XII-10: Percent of Participants and Non-participants That Installed Non-Rebated Energy Efficient Equipment

	Non-Participant	Participant
Did not install energy-efficient equipment	389 89.2%	370 84.9%
Installed energy-efficient equipment	47 10.8%	66 15.2%

E. Estimates of Net Program Impact

Each of the three methods described in this section provide the information needed to computed net-to-gross ratios (NTG). As shown in Table XII-11, the NTG ratios for the self-report, discrete choice, and billing regression analyses were 0.57, 0.55, and 0.70, respectively. These ratios were applied to both the GWh and MW estimates of statistical gross savings to estimate net savings. The corresponding net realization rates (defined as the evaluation estimate of net savings divided by the program estimate of net savings) were 0.73, 0.71, and 0.90, respectively. These NTG ratios were also used to compute net savings for therms, although no statistical adjustment was made to the engineering estimate of gross therm savings.

While the three NTG ratios shown in Table XII-11 are not statistically different, they were produced by very different approaches, each with its own set of advantages and disadvantages. This is a classic case of triangulation in which the uncertainty surrounding a given estimate is reduced by obtaining additional points of comparison using complementary techniques. Thus, in the current study, while the uncertainty surrounding the individual estimates can be quite large, the uncertainty surrounding the "true" estimate is reduced by virtue of the strong agreement among the three estimates. These three estimates can be said to converge on the "true" estimate. Although the M&E Protocols do not allow NTG ratios based on self-reports, these NTG ratios can be used to provide a sanity check on those methods that are allowed by the Protocols. The self-report-based NTG ratio of 0.57 has clearly provided such a sanity check. While the discrete choice model, which examined the choices made by customers, was a somewhat unstable model, it did arrive independently at an estimate that was reasonably close to the other two. The billing regression analysis produced the highest estimate but one that was still close to the two NTG ratios used for the Customized and Express Programs.

Table XII-11: Summary of Program-Level Evaluation Results

	Electric Usage		Electric Demand		Gas Usage	
	GWh/yr (9)	90% CI (1)	MW (9)	90% CI (1)	kTherms/yr (9)	90% CI (1)
PG&E's PROGRAM DATA BASE						
Gross Savings	**65.10**	--	**15.34**	--	**544.9**	--
Net-to-Gross Ratio (2)	**0.71**	--	**0.68**	--	**0.75**	--
Net Savings	**46.45**	--	**10.49**	--	**408.6**	--
EVALUATION RESULTS						
Gross Realization Rate (3)						
Engineering	**0.76**	0.61 to 0.90	**1.16**	0.98 to 1.34	**1.78**	1.00 to 2.57
Statistical	**0.92**	0.72 to 1.12	**1.09 (4)**	--	--	--
Gross Savings						
Engineering	**49.36**	39.8 to 58.9	**17.75**	15.0 to 20.5	**971.2**	544 to 1398
Statistical	**59.89**	47.1 to 72.7	**16.77**	--	--	--
Net-to-Gross Ratio						
Self-Report	**0.57**	0.32 to 0.82 (5)	**0.57**	0.32 to 0.82 (5)	**0.57**	--
Discrete Choice	**0.55**	0.23 to 0.87	**0.55**	0.23 to 0.87	**0.55**	--
Billing Regression	**0.70**	-4.1 to 5.5	**0.70**	-4.1 to 5.5	**0.70**	--
Net Savings (6)						
Self-Report	**34.14**	--	**9.56**	--	**553.6 (8)**	--
Discrete Choice	**32.94**	--	**9.22**	--	**534.2 (8)**	--
Billing Regression	**41.92**	--	**11.74**	--	**679.8 (8)**	--
Net Realization Rate (7)						
Self-Report	**0.73**	--	**0.91**	--	**1.35**	--
Discrete Choice	**0.71**	--	**0.88**	--	**1.31**	--
Billing Regression	**0.90**	--	**1.12**	--	**1.66**	--

NOTES

1. Confidence interval (CI) at a 90% confidence level.
2. Assumes a net-to-gross ratio of 0.75 for Customized Program measures, 0.67 for Express Program measures.
3. Evaluation gross savings / program gross savings.
4. The statistical gross realization rate of 0.92 was adjusted upwards towards the engineering MW realization rate of 1.16 since the major reason for program/evaluation discrepancies was a difference in assumed operating hours.
5. This is an uncertainty range, rather than a confidence interval.
6. Based on statistical gross savings estimates.
7. Evaluation net savings / program net savings.
8. Estimates of net therm savings were derived by multiplying electrical net-to-gross ratios and the engineering estimate of gross savings.
9. These units apply to all number below except for realization rates and net-to-gross ratios.

XIII. Analysis of Lighting/HVAC Interactions

A. Introduction

Of the 139 sites subjected to an engineering analysis, 53 sites (accounting for 70 HVAC items) also installed energy-efficient lighting measures for which PG&E paid a rebate in 1994. In many cases, these lighting retrofits affect the total cooling consumption, and thus the savings associated with the HVAC measures. Engineering and statistical analyses of the interaction between these lighting and HVAC measure savings were performed to quantify the effect of the interaction.

Typically in a commercial building, heat generated by interior lighting creates much of the internal cooling load. Changing this lighting load consequently changes the internal cooling load. For instance, installing energy-efficient lighting fixtures throughout an entire office complex would not only reduce the amount of electricity used to light the building, but would also significantly reduce the amount of waste heat generated by the lights. This would, assuming all other internal loads remained constant, reduce the cooling load in the building. If the existing cooling system were replaced with a more efficient system before the lights were changed, it would reduce cooling electric consumption by a certain amount, say 1,200 kWh . If the cooling system were replaced after the lights were changed, the reduction in cooling consumption would be less, say 1,000 kWh. The efficient lighting reduced the cooling load and thereby reduced the electric savings associated with more efficient cooling equipment. This is one example of the interaction between lighting and HVAC measure savings.

It is possible, however, for efficient lighting to increase, rather than reduce, HVAC measure electric savings. Two particular measures where this increase in savings might be expected to occur are adjustable speed drives (ASD) and a conversion to a variable air volume (VAV) system. Most of the electric savings for these measures result from fan motors operating less frequently and at lower loads. When fans operate at full load, an adjustable speed drive and a conventional constant volume or inlet-vane-controlled fan will require about the same amount of power. However, if the fans operate at a given part load, ASD fans will draw much less power than conventional fans. This means that the lower the percentage load on the fans, the higher the savings that would result. Reducing the lighting load reduces the percentage load on the fans. Because of this, the electric savings attributable to the HVAC measure actually increase because of the efficient lighting.

Gas savings associated with HVAC measures for the most part diminish when efficient lighting is installed, regardless of the measure. Lighting in buildings produces waste heat, which reduces the heating load on the HVAC system. When efficient lighting is installed, the amount of waste heat decreases, increasing the load on the heating system. Since the heating system must work harder with efficient lighting than without it, any HVAC measure saves gas will produce greater savings with efficient lighting.

B. Engineering Methodology

The engineering analyses of lighting/HVAC interaction required several steps. First, items affected by lighting measures were identified. Then, additional data about the lighting were gathered as necessary. The original DOE 2.1E models used to estimate engineering gross savings were then modified using the new lighting data. After running these new models, the overall interaction was calculated and analyzed. These steps are described in more detail below.

Identification of Lighting-Affected Items

The 173 HVAC items subject to engineering analysis represented 140 control numbers. The premise identification numbers associated with these 140 control numbers were then identified and matched against PG&E's program data base to identify all control numbers associated with the HVAC-measure-affected premises. From this expanded list of control numbers, all lighting measure rebates paid in 1994 were identified. Seventy (70) of the 173 HVAC items were associated with control numbers that received 1994 rebates. Copies of the lighting rebate applications for these control numbers were obtained from PG&E. After the applications were examined, 22 HVAC items were eliminated because the area affected by the HVAC measure did not overlap with the area affected by the lighting measure, leaving a total of 48 items to reanalyze.

Additional Lighting Data Collection

Before performing lighting surveys, field surveyors reviewed the lighting rebate applications to become familiar with the types, quantities, and approximate locations of rebated lighting at a site. For some of the 48 lighting-affected items, field surveyors were able to collect additional data about the rebated lighting while they performed the cluster/matched-pair on-site survey. For the others, surveyors needed to schedule a follow-up survey specifically to examine the lighting measures.

In both cases, surveyors took a census or a sample of the installed and "on" rebated lighting in each zone affected by an HVAC measure. As much as possible, surveyors attempted to group their counts of rebated lighting to correspond to the thermal zones established for each site's DOE 2.1E modeling. Separate inventories were taken for lighting capacity measures (such as compact fluorescent bulbs) and for control measures (occupancy sensors). The counts of installed rebated lighting capacity were used to calculate incremental lighting power densities (LPD) for the engineering analysis. The LPD for the lighting analysis is actually the incremental LPD, that is, the demand (watt) savings per square foot that can be attributed to the energy-efficient lighting.

Additional DOE 2.1E simulation runs

To develop the original engineering gross estimates of savings, two, and in some cases three models were developed. The pre-condition and as-built models represent the HVAC, lighting, and operating conditions before and after the HVAC measure was installed. An additional Title 20 model was also created to simulate Title 20 baseline conditions for those items affected by the standards. Section V describes each of these three model types in more detail.

To estimate the effects of the efficient lighting on the HVAC measures, two of the original DOE 2.1E models for each item were modified. The incremental LPD changes from the field survey were incorporated into the original DOE 2.1E as-built and pre-condition models, creating two new models representing the base and efficient HVAC cases <u>before</u> efficient lighting was installed. For items with Title 20 baseline models, the Title 20 model, rather than the original pre-condition model, was used. Simulations were run with the two new models, resulting in estimates of the HVAC impacts that would have occurred had efficient lighting not been installed.

Computation of Interaction

As with the original efficient, base, and Title 20 base simulations, these pre-lighting base and efficient simulations produced estimates of hourly kW load for one year. These new hourly estimates were processed using the same methodology as the original post-lighting estimates to generate annual estimates of kW, kWh, and therm savings. Pre- and post-lighting measure HVAC savings were calculated for each item, and these savings estimates were then aggregated to produce estimates of the lighting/HVAC interaction for each program and overall.

C. Engineering Results

Table XIII-1 shows how efficient lighting retrofits affected estimates of HVAC program savings. Of 173 HVAC items subjected to engineering analysis, only 48 items, representing 23% of the total program estimates of GWh savings, were affected by the lighting measures. As a result, the net effect of the lighting measures on program savings estimates was quite small. Overall, lighting retrofits increased GWh savings by 0.35%, MW savings by 0.27%, and kTherm savings by 0.77%. The effect on GWh savings for the Retrofit Express Program was particularly small (0.04% increase in savings) compared to that for the Retrofit Customized Program (0.52% increase). The effect on MW savings varied across the two programs: savings for the Customized Program increase 1.10%, but dropped 0.62% for the Express Program. The effect on kTherms was fairly uniform, with 0.74% and 0.95% savings increases for the Customized and Express Programs, respectively.

The fact that efficient lighting for the most part caused GWh and MW savings estimates to increase at first glance seems surprising, but a glance at Table XIII-2 reveals the reason. Of the 48 items affected by lighting rebates, 33 items had a positive GWh interaction, meaning pre-lighting HVAC savings were greater than post-lighting HVAC savings. However, these 33 items only accounted for 30% of the HVAC savings among the 48 lighting-affected items. As a group, GWh savings for these items with a positive interaction increased by 3.2% going from post-lighting to pre-lighting. This increase, however, is more than offset by the group of 15 items with negative interactions. HVAC savings for the negative interaction group accounted for 70% of the HVAC savings among the lighting-affected items. For the negative interaction items as a group, HVAC savings decreased by 3.6% going from post-lighting to pre-lighting . The HVAC measures for most of these items are either adjustable speed drives or conversion to VAV, which as discussed in the introduction portion of this section, generally have exactly this effect on savings. HVAC savings for the negative interaction group accounted for 15% of the program savings. In short, the weighted effect of the negative interaction group (3.6% reduction in GWh savings) overwhelmed the effect of the positive interaction group (3.2% increase in GWh savings), resulting in a net negative interaction for both GWh and MW savings (0.4% reduction in GWh savings).

Examining the unweighted results for the 48 lighting-affected items only confirms that effect of the interaction is small. The unweighted GWh, MW, and kTherm savings for the 48 items increased with efficient lighting by only 1.70%, 2.17%, and 0.34%, respectively. For the 70 items at lighting-affected premises, which includes 22 items with no lighting interaction, the unweighted GWh, MW, and kTherm savings increased by 1.23%, 1.80%, and 0.32%, respectively.

Table XIII-1: Effects of Interaction between HVAC and Efficient Lighting, by Program

Program	GWh Savings Post (with Eff. Lights)	GWh Savings Pre (without Eff. Lights)	% Diff.	MW Savings Post (with Eff. Lights)	MW Savings Pre (without Eff. Lights)	% Diff.	kTherm Savings Post (with Eff. Lights)	kTherm Savings Pre (without Eff. Lights)	% Diff.
Custom	31.96	31.80	0.52	9.18	9.08	1.10	814.40	808.38	0.74
Express	17.40	17.39	0.04	8.57	8.62	0.62	156.81	155.33	0.95
Total	**49.36**	**49.19**	**0.35**	**17.75**	**17.70**	**0.27**	**971.21**	**963.71**	**0.77**

Table XIII-2: Breakdown of Overall Interaction Effects

HVAC/ Lights Interaction	No. of Items	% of Program HVAC Savings	GWh Savings Post (with Eff. Lights)	GWh Savings Pre (without Eff. Lights)	GWh Savings % increase Post-to-Pre-Lights	MW Savings Post (with Eff. Lights)	MW Savings Pre (without Eff. Lights)	MW Savings % increase Post-to-Pre-Lights	kTherm Savings Post (with Eff. Lights)	kTherm Savings Pre (without Eff. Lights)	kTherm Savings % increase Post-to-Pre-Lights
WEIGHTED PROGRAM RESULTS											
Positive kWh Interaction	33	7	3.45	3.56	3.21	2.93	3.07	4.88	107.2	105.6	-1.56
Negative kWh Interaction	15	16	7.90	7.62	-3.59	3.06	2.87	-6.26	411.3	405.5	-1.42
No Interaction	125	77	38.01	38.01	0.00	11.8	11.8	0.00	452.7	452.7	0.00
Total	**173**	**100**	**49.36**	**49.19**	**-0.35**	**17.7**	**17.7**	**-0.27**	**971.2**	**963.7**	**-0.77**
Unweighted Results for All Lighting-Affected Items	**48**	**--**	**4.64**	**4.56**	**-1.70**	**2.38**	**2.33**	**-2.17**	**184.9**	**184.3**	**-0.34**
Unweighted Results for All Items at Lighting-Affected Premises	**70**	**--**	**6.40**	**6.33**	**-1.23**	**2.87**	**2.82**	**-1.80**	**191.5**	**190.9**	**-0.32**

D. Statistical Analysis

A variety of functional forms were tested to estimate the interaction of HVAC and lighting as part of the statistical model of gross savings described in Sections VI and XI. Ultimately, we settled on a rather straightforward multiplicative form of the interaction that involved multiplying a dummy variable representing the installation of a program-related HVAC and a dummy variable representing PG&E's original estimate of the savings associated with the lighting measure.

As was seen in Table XI-1 in Section XI, the very large negative coefficients on all four interaction terms indicate the increased benefit associated with a lighting measure in the presence of an HVAC measure. However, there are two important caveats. First, despite the fact that the number of premises participating in the regression model was reasonably large (n=376), only one of the four HVAC/lighting interaction terms was significant beyond the .05 level. The other three terms are very far from significant. Given these coefficients, simulations of the estimated models suggest very large savings being attributed to the interaction terms. However, these savings, approximately 30% of the HVAC savings, are implausibly large. Such a large benefit may be merely an artifact of customer attributes or motivations that select them into a higher level of participation. That is, this interaction term may be reflecting the fact that some large firms, engaging in both efficient HVAC and lighting, are also aggressively pursuing energy efficiency on other fronts outside the program, thus producing additional savings. These additional savings may have been mistakenly attributed to the HVAC/lighting interaction. Our conclusion is that more information about premises that are installing both HVAC and lighting measures is required in order to more confidently identify such interaction effects.

The team responsible for the evaluation of lighting technologies paid in 1994 by the commercial retrofit programs also made an effort to investigate the interaction of the lighting and HVAC impacts. In their final billing regression model, an independent variable was used to capture the interactive effect between lighting and HVAC measures. The regression equation took the following functional form:

> Billing Usage Difference = $\alpha *$(Engineering Lighting Impact) + $\beta *$(Other Measure Impacts as % of Usage, Including HVAC) + $\gamma *$(HVAC Dummy)$*$(Engineering Lighting Impact) + Other Vars + Error

Under this specification, the estimated coefficient γ reflects the average impacts of implementing both lighting and HVAC measures as a percentage of the engineering estimated lighting impacts. This term was expressed as a percentage of lighting impact only because the engineering estimated HVAC impacts were not available at the time of this analysis.

Realization rates were estimated for various lighting measures based on a sample of 936 observations (see Section 3.3 of the 1994 Commercial Retrofit Evaluation, Lighting Technologies Evaluation Report for detail). However, there were only six (6) customers in the sample who implemented both lighting and HVAC measures and could be used to support the estimation of γ. As result of the small sample size, the estimated γ value is not statistically significant at the 90% confidence level and therefore was excluded from the final model through a stepwise selection procedure. If included in the model, it would have had a mean value of 57% , with a wide range of -88% to 202% at the 90% confidence level. Undoubtedly this result would not supply a reasonable estimate because of the sample size limitation. Another possibility could be that the combined effect is too small to be reliably estimated in a regression analysis, even with a large sample size. In either case, this regression result does not provide any indication of the actual size or range of the combined effect.

XIV. Recommendations Concerning the Design of Future Programs

The purpose of this final section is to provide recommendations concerning the design of new retrofit programs to be offered by PG&E in 1997. The recommendations in this section are organized under two categories. The first group deals with a number of technical implementation issues, that if adopted, would improve the PG&E's ability to accurately estimate savings. These recommendations are as follows:

1. Reduce kWh savings estimates for certain measures. The evaluation found that the program overstated kWh savings for window film, evaporative coolers, and cooling towers by 233%, 1225%, and 280%, respectively.

2. Reduce kW savings estimates for certain measures. The evaluation found that the program overstated kW savings for evaporative coolers and cooling towers by 415% and 295%, respectively.

3. Ensure that evaporative coolers are replacing, rather than supplementing, existing cooling systems. Customers who are adding evaporative cooling to an uncooled area should be processed under a new construction, rather than a retrofit, program. To evaluate savings for such customers, evaporative cooling usage should be compared with a well-defined baseline usage. Customers who are replacing existing cooling with evaporative cooling should be required to physically remove or permanently disconnect their existing cooling systems to receive a rebate.

4. Take credit for additional kW savings for programmable thermostats and EMS, and additional therm savings for programmable thermostats, EMS, and conversion to VAV. The evaluation found that the program understated kW and therm savings for thermostats by about 84% and 100%, respectively. kW and therms savings for EMS were understated by 90% and 33%, respectively. Therm savings for VAV conversion were underestimated by 78%. For programmable thermostats, an algorithm which accounts for site-specific operating conditions would yield more accurate estimates of savings. For EMS and VAV conversions, a more rigorous savings calculation method, such as modeling, would provide better estimates. Also, providing training to customers so that they can learn how to take full advantage of EMS features might yield even greater energy savings.

5. Account for negative therm savings that occur for reflective window film and adjustable speed drive measures. These measures as a whole reduced the evaluated therm savings by about 8%.

6. Revise the equivalent full load cooling hours (EFLCH) tables for the Retrofit Express Program to provide more site-specific values for cooling system run time.

The second group of recommendations suggests ways to improve future program evaluations. These recommendations would either reduce the cost of future evaluations, improve the accuracy of savings estimates, or aid in compliance with the M&E Protocols. These recommendations are as follows:

1. Record the affected floor area for each measure and the area served by the meter or group of meters that are affected by each measure.

2. Identify all affected meters for each measure, i.e., allow for more than one control number per measure.

3. Maintain a unique facility identification number system that can be used to identify all items that affect the same facility (a building or group of buildings, at a single location, controlled by one organization). This facility ID number would take the place of the premise ID for evaluation purposes.

4. Improve quality control so that control numbers listed on the applications always match the actual control numbers for the measure-affected meters.

5. Improve data base tracking of installation dates and PG&E account representative names. Installation dates in the data base should refer to the date the measure was actually operational or the date the owner's warranty coverage begins.

6. Create a standardized cover sheet for Retrofit Customized measures to document key information, such as savings estimates for each measure, assumptions about baseline and efficient conditions used to estimate savings, and clear descriptions of the as-built conditions.

APPENDIX A

Survey and Engineering Data Base (Including Annotated Survey Instruments)

Appendix A

Survey and Engineering Data Base (including Annotated Survey Instruments)

A.1 Introduction

The purpose of this appendix is to document the survey and engineering data bases that were developed to support both the engineering and statistical estimates of gross and net savings. The data base contains information gathered via telephone surveys, on-site inspections, short-term end-use metering, and engineering calculations. All of the data are available in SAS Version 6 transport files, which can be read by any version of SAS on any currently supported platform, e.g., SAS PC, SAS PC for Windows, and SAS under TSO. The files that comprise the data base are available on a PC-compatible diskette, in the form of a self-extracting ZIP file.

The transport files are partially self-documenting, as they contain labels for each variable, along with information on each variable's data type and format. This information can be accessed via the SAS PROC CONTENTS procedure. Also provided are the telephone and on-site surveys, annotated with variable names so that the user can understand the point of origin for the variables contained in the data base. Finally, two SAS PROC FORMAT jobs are provided that define value labels for each coded variable.

A.2 Data Sets from Telephone Surveys

Within the self-extracting ZIP file (HVACRF94.EXE) are three files containing the telephone survey data base. The first file, PHONE.V6X, is the SAS transport file which contains the data set PHONE. PHONE contains both participant and non-participant telephone survey results. Participants can be identified by the variable PART. The second file, PHOFMTS.SAS, is a SAS PROC FORMAT job. This file defines value labels for each of the coded variables that appear in the participant data set. The third file, PHOFLINK.SAS, is a SAS job which cross-references variable names and the name of the format that defines each variable's labels.

PHONE can be linked to the on-site survey data sets via the field PREMID.

A.3 Data Sets from On-Site Surveys

Within the self-extracting ZIP file (HVACRF94.EXE) are two files containing the information gathered via on-site inspection and subsequent engineering calculations. The first file, ONSITE.V6X, is a SAS transport file containing the data set called ONSITE. ONSITE contains on-site and engineering data for all 173 items that received an on-site engineering survey and analysis. It is organized by the key variables APPCD, ITEMNUM, PROGYR, and TITLE20, which are indicated in the variable labels that can be accessed via PROC CONTENTS by the words key 1, key 2, key 3, and key 4. For items affected by Title 20 standards, ONSITE contains two observations, one for the Title 20 base case, the other for the pre-condition (not constrained by Title 20) case. The variable values for the two observations are the same for all variables except for those expressing energy consumption or savings. Data in ONSITE can be linked to the telephone surveys through the variable PREMID, and can be linked to the short-term end-use data through the variable CONTROL.

The second file, OSFMTS.SAS, is a SAS PROC FORMAT job. This file defines value labels for each of the coded variables that appear in the on-site survey data sets.

A.4 Data Sets from Short-Term End-Use Metering

Within the self-extracting ZIP file (HVACRF94.EXE) are five SAS transport files containing the hourly kW data gathered from short-term end-use metering. These files are named SITE1.V6X through SITE5.V6X, with each file corresponding to one site. Each file contains hourly kW readings for each logger channel, time and date stamps, and in some cases, temperature readings. Each file also contains the site control number. For sites where multiple loggers were installed, data from different loggers can be differentiated through the logger number variable in the file.

This appendix also contains information sheets for each site. These sheets provide detailed information about HVAC characteristics, measurement plans, and unusual characteristics of the data at each site. The information includes the following:

- PG&E control number and application code
- Site type
- Area (square footage) of building
- Type of heating and cooling systems
- One-time power measurement descriptions and values
- Hourly power measurement description (number of data loggers, dates installed, channel assignments and descriptions)

A.5 Annotated Survey Instruments

Annotated versions of the participant telephone, non-participant telephone, and on-site survey instruments are provided on the following pages. These instruments are annotated with the variable names, so that the user can understand the point of origin for the variables contained in the data sets discussed in the previous sections of this appendix.

APPENDIX B

Net and Gross Savings Results in M&E Protocol Format

Appendix B

Net and Gross Savings Results in M&E Protocol Format

The purpose of this appendix is to provide a consolidated tabulation of results from this evaluation which meet the reporting requirements defined by the California Public Utility Commission's Measurement and Evaluation (M&E) Protocols. Specifically, the tables and descriptions provided by this appendix are designed to provide the information requested in M&E protocol Tables 5, 6, 7, C-4, and C-12.

The first part of this appendix contains four tables which together, provide the information required in Table 6 of the Protocols. The Designated Unit of Measurement for all estimates is the measure-affected floor area, expressed in square feet. The tables are as follows:

Table B-1: First-Year Impacts

Table B-2: First-Year Impacts per Designated Unit of Measurement

Table B-3: Participant Group, Comparison Group, and Program Participant Data

Table B-4: Market Segment Data

Certain items in Table 6 of the protocols address unit energy consumption (UEC). The protocols deem these items optional in instances where the models employed in the evaluation cannot yield appropriate UECs. These optional items are not included in the tables below. The engineering portion of the evaluation yielded base and efficient energy consumption estimates for most of the evaluated items, but a small number of sites, it was impossible to develop consumption estimates. Because of this, program-wide engineering estimates of gross energy consumption and UEC could not be determined. The statistical portions of the evaluation as well for the most part only examined energy savings and did not produce estimates of energy consumption.

The second portion of this appendix provides data quality and processing documentation as discussed in Table 7 of the Protocols. The numbering scheme for this portion corresponds to that in Table 7.

B.1 Response to Protocol Table 6

Table B-1: First-Year Impacts (HVAC end use)

	Avg. Savings per Premise (2A)	Confidence Interval at a Confidence Level of: 80% (5)	90% (5)	NTGR (3A)	Realization Rate (2D) Gross	Net
Electric Consumption (kWh)						
Gross						
Statistical	51,990	43,343 to 60,636	40,857 to 63,122	--	0.92	--
Net						
Billing Regression	36,393	-289,145 to 465,909	-398,269 to 575,053	0.70	--	0.90
Electric Peak Demand (kW)						
Gross						
Statistical	14.51	--	--	--	1.09	--
Net						
Billing Regression	10.16	--	--	0.70	--	1.12
Gas Consumption (therms)						
Gross						
Engineering	841.9	--	--	--	1.78	--
Net						
Billing Regression	589.3	--	--	0.70	--	1.66

Notes
1. Numbers in parentheses refer to applicable section of Table 6 of the M&E Protocols.
2. NTGR = net-to-gross ratio (net savings divided by statistical gross savings).
3. Gross realization rate = evaluation gross savings divided by program gross savings.
4. Net realization rate = evaluation net savings divided by program net savings.
5. Average savings per premise were calculated by dividing total program savings by the estimated number of premises in the sample frame (1,152 premises). A premise is loosely defined as all of the facilities belonging to a customer at a given location. The statistical analyses used the premise as the basic unit of analysis. The estimate of 1,152 premises in the sample frame was determined by finding out the number of control numbers and the ratio of control numbers to premise for each premise in the statistical sample. Weights were applied to these numbers to estimate the total number of control numbers and the average number of control numbers per premise for the entire study sample frame, and from this, the total number of premises was derived.

Table B-2: First-Year Impacts per Designated Unit of Measurement (HVAC end use)

	Avg. Savings per DUM (2A)	Confidence Interval at a Confidence Level of: 80% (5)	90% (5)	NTGR (3A)	Realization Rate (2D) Gross	Net
Electric Consumption (kWh/sq.ft.)						
Gross						
Statistical	1.288	1.074 to 1.502	1.012 to 1.563	--	0.92	--
Net						
Billing Regression	0.902	-7.163 to 11.54	-9.866 to 14.245	0.70	--	0.90
Electric Peak Demand (W/sq.ft.)						
Gross						
Statistical	0.360	--	--	--	1.09	--
Net						
Billing Regression	0.252	--	--	0.70	--	1.12
Gas Consumption (therms)						
Gross						
Engineering	0.021	--	--	--	1.78	--
Net						
Billing Regression	0.015	--	--	0.70	--	1.66

Notes

1. Numbers in parentheses refer to applicable section of Table 6 of the M&E Protocols.
2. NTGR = net-to-gross ratio (net savings divided by statistical gross savings).
3. Gross realization rate = evaluation gross savings divided by program gross savings.
4. Net realization rate = evaluation net savings divided by program net savings.
5. Average savings per DUM were calculated by dividing the average savings per premise in Table B-1 by the average square footage per premise (40,369 square feet). This average square footage was determined by applying weights to the square footages in the statistical sample, thus resulting in an average square footage for the sample frame. Participant sample square footages were obtained during the telephone survey.

Table B-3: Participant Group, Comparison Group, and Program Participant Data

	Participant Group	Comparison Group	Program Participants
Designated Units (square feet)			**--**
Pre-installation Average (4A)	40,369	16,336	--
Post-installation Average (4B)	40,369	16,336	--
Number of Measures Installed (6A, C, B)	**669**	**30**	**2,108**
A/C: Central Air	227	2	912
Adjustable Speed Drive	43	1	82
Air-cooled Water Chiller	14	--	22
Convert to VAV System	3	--	6
Cooling Tower	27	--	38
Energy Management System	36	4	58
Evaporative Cooler	14	--	26
Gas Absorption A/C	1	--	1
Reflective Window Film	134	--	313
Resize HVAC	3	--	3
Water-cooled Water Chiller	20	--	30
Other (see note below)	147	11	512
Low Savers (see note below)	--	12	105

Notes:

1. Numbers in parentheses refer to applicable section of Table 6 of the M&E Protocols.
2. CL = confidence level.
3. "Other" refers to various measures, including programmable thermostats, packaged terminal air conditioners, HVAC controls, and others.
4. "Low Savers" were measures that as a group, accounted for less than 5% of program savings. They included bypass/delay timers, time clocks, condensers, air economizers, water-source heat pumps, and other measures.

Table B-4: Market Segment Data

Building Type	**Percentage of Program Participants**
Office (large)	1.7%
Office (small)	29.9%
Restaurant	9.8%
Retail (large)	0.1%
Retail (small)	11.9%
Food	4.9%
Refrigerated Warehouse	0.2%
Non-refrigerated Warehouse	4.4%
Elementary or Secondary School	8.0%
College or University	1.5%
Hospital	0.5%
Clinic	4.8%
Hotel or Motel	3.2%
Miscellaneous	5.5%
Personal Repair	3.4%
Commercial Services	10.3%
	100%

B.2 Response to Protocol Table 7

A. Overview Information

1. Study Title: 1994 Commercial HVAC Evaluation; Study ID: 312.

2. Customized and Retrofit Express Programs. All applications paid in 1994.

3. Evaluation covers HVAC measures.

4. Engineering gross savings estimated via DOE 2.1E simulations, see Section V. Gross impacts model used to estimate gross savings, see Section VI. Three methods used to estimate NTG ratio: (a) self-report, see Section VII; (b) discrete choice, see Section VIII; (c) billing regression, see Section IX.

5. Participant and comparison group definition vary depending on the type of analysis performed. Gross savings analysis involved only participants, see Section X. Participant and comparison groups are defined for the gross model in Section VI, discrete choice NTG ratio model in Section VIII and billing regression net savings model in Section IX.

6. The engineering gross analysis participant sample comprised 173 HVAC items paid in 1994. A sample of 438 premises were included in the SAE model of gross savings. A sample of 438 participants and a sample of 442 nonparticipants were used in the discrete choice and billing regression analysis of NTG ratio.

B. Database Management

1. Figure II-1 (Section II) shows the relationship between various data sources and modeling activities.

2. The sources for all data element are described in Section IV.

3. Sample attrition is discussed in Section III. Data attrition is discussed in Appendix C.

4. Quality control checks imposed in the construction of the master statistical analysis file are described in Appendix C.

5. All data collected were used in one of the engineering or statistical analyses.

C. Sampling

1. A complete description of the sample design for the statistical and engineering analysis samples is provided in Section III.

2. Annotated copies of the on-site and telephone survey data collection instruments are provided in Appendix A. Sample disposition is documented in Section III. An analysis of non-response bias is presented in Appendix D.

3. Descriptive statistics for model variables are provided for the gross savings model in Appendix E, the billing regression net savings model in Appendix F, and the discrete choice NTG ratio model in Appendix G.

D. Data Screening and Analysis

1. Treatment of Outliers, Missing Data Points, and Weather Adjustment

Billing Regression Analysis of Net-to-Gross Ratio

Two outliers that had serious effects on the model coefficients were detected using the DFITTS statistic. They were removed from the energy-using model. For details see Chapter XII.

Billing Regression Analysis of Gross Impacts
No premises were dropped from the analysis. For premises with 1 or more DFFITS values greater than 1.0, we rescored their weights by 1/4 in order to mitigate their influence without removing them from the model. Only three customers were weighted down in this way.

Discrete Choice Analysis of Net-to-Gross Ratio
Twelve participants and 8 nonparticipants were removed from the analysis for various reasons such as missing data. More details are provided in Appendix C.

2. Background Variable Control

Billing Regression Analysis of Net-to-Gross Ratio

Many background variables were tested in the models, and the final models contained actual weather (normalized could not be used in this model), employment, building types, business hours, self-reported equipment installations, and cooled square footage. See Chapter XII for details.

Billing Regression Analysis of Gross Impacts
Several macro-economic indicators were acquired for the purpose of accounting for the separate effect of prevailing economic conditions on consumption: 1) quarterly commercial employment figures for finance, insurance and real estate, services, and trade, 2) quarterly taxable sales, and 3) real personal income. Since this information was provided by Metropolitan Statistical Area (MSA), we were able to assigned the appropriate values to each sample premise based on its MSA membership. Also, the California Consumer Price Index was provided but only at the State-level. Finally, premise-level commercial sector consumption was aggregated by SIC to conform to the CEC-based categories of building type. In addition, aggregation included a CEC climate zone so that each kWh value represents the combination of a two-digit SIC category and a climate zone. Therefore, a value appropriate to each sample member's business type and climate zone was assigned.

Discrete Choice Analysis of Net-to-Gross Ratio
N/A

3. Data Screening

Billing Regression Analysis of Net-to-Gross Ratio

Screening procedures are described in detail in Appendix C.

Billing Regression Analysis of Gross Impacts

Screening procedures are described in detail in Appendix C.

Discrete Choice Analysis of Net-to-Gross Ratio

Screening procedures are described in detail in Appendix C.

4. Regression Statistics

Billing Regression Analysis of Net-to-Gross Ratio

Standard regression statistics are provided for the final models in Chapter XII. Those for models tried but not used are in Appendix F.

Billing Regression Analysis of Gross Impacts
Standard regression statistics are provided for the final models in Chapter XII. Those for models tried but not used are in Appendix E.

Discrete Choice Analysis of Net-to-Gross Ratio
Standard logit model statistics are provided for the final models in Chapter XII. Those for models tried but not used are in Appendix G.

5a. Heterogeneity

Billing Regression Analysis of Net-to-Gross Ratio

Differences across customers were addressed in the models by entering variables that would account for heterogeneity in consumption, especially change in consumption. Such variables included building type, business hours, square footage, and other equipment installations.

Billing Regression Analysis of Gross Impacts
Customer-specific intercepts were used to control for heterogeneity.

Discrete Choice Analysis of Net-to-Gross Ratio
N/A

5b. Changes Over Time

Billing Regression Analysis of Net-to-Gross Ratio

Changes over time were handled differently for different types of variables. Weather, economic and consumption variables were differenced by comparable months. Installations of equipment, changes in business hours and square footage are handled by taking account of the point in time that the change took place relative to the program installation. Details are in Chapter IX.

Billing Regression Analysis of Gross Impacts
Data collection efforts focused on collecting data that was likely to change over time and thus explain changes in consumption other than those induced by the program. Such data included a variety of economic data, already described, weather data and data on changes in business hours and square footage, and additions of equipment, either through the PG&E program or not, that may reduce or increase load.

Discrete Choice Analysis of Net-to-Gross Ratio
N/A

5c. Self-Selection Bias

Billing Regression Analysis of Net-to-Gross Ratio

Self selection bias was handled by the inclusion of two inverse Mills ratios. The procedure and results are described in Chapter XII, pages 5-6.

Billing Regression Analysis of Gross Impacts
Some have argued that not including an inverse Mills ratio in the model involving only participants inevitably produces biased estimates. We argue here that if one is interested in estimating the first-year gross impacts, all things being equal, the estimate is unbiased. While it is true that participants in any given year will self-select into the program, we are only interested in estimating the impact on these participants. Certainly, forecasters and DSM program planners are interested in the extent to which one can generalize the impacts estimated for a given program cohort to future program participants, but this is not the objective of this program evaluation.

Discrete Choice Analysis of Net-to-Gross Ratio
Explicitly controlling for self-selection bias is one of the main reasons for using nested logit.

5d. Data Omission

Billing Regression Analysis of Net-to-Gross Ratio

All data collected were considered for inclusion in this analysis.

Billing Regression Analysis of Gross Impacts
All data collected were considered for inclusion in the regression analysis.

Discrete Choice Analysis of Net-to-Gross Ratio
All data collected for this model were considered for inclusion.

5e. Net Impacts

Billing Regression Analysis of Net-to-Gross Ratio

Net impacts are calculated by adding to the participation coefficient to the inverse Mills ratio coefficient (which is interacted with the participation variable), evaluated at the mean of the inverse Mills ratio for participants.

Billing Regression Analysis of Gross Impacts
Estimates of gross savings were used to determine realization rates which were used to adjust the denominator in calculating the net-to-gross ratio.

Discrete Choice Analysis of Net-to-Gross Ratio
The gross savings estimates contained in the Program Database were multiplied by this unitless net-to-gross ratio to obtain program-level net savings.

6. Error in Measuring Variables

The determination of installation date was very imprecise. The best estimate was used to form a pivot date to define pre and post installation periods, and a sensitivity analysis was done to test the sensitivity of the model to that error. The model appears to be insensitive to this error. This test is described in Chapter XII. Careful attention was paid to plugging missing kWh data, developing tools for aggregating kWh to the premise level. Also careful attention was given to account matching to be sure that the correct account number and its associated consumption would be linked to the correct premise. In addition, the gross impacts analysis benefited from the collection of onsite data for 139 sites in order to minimize measurement error in the engineering priors from the Program Database.

7. Autocorrelation

Billing Regression Analysis of Net-to-Gross Ratio
Autocorrelation was not an issue in the change model used.

Billing Regression Analysis of Gross Impacts
There is considerable intra-customer serial correlation identified. While left unaddressed, it does not threaten the consistency of the estimates that have been calculated. However, it does make their statistical precision less than it could have been were serial correlation either not present or corrected.

Discrete Choice Analysis of Net-to-Gross Ratio
N/A

8. Heteroskedasticity

Billing Regression Analysis of Net-to-Gross Ratio
Heteroskedasticity was assessed by inspection of residuals and by the Breusch/Pagan tests. This is described in Chapter XII.

Billing Regression Analysis of Gross Impacts
Heteroskedasticity was tested for but was not considered serious enough to warrant attention. See Chapter XI for details regarding this diagnostic.

Discrete Choice Analysis of Net-to-Gross Ratio
Heteroskedasticity was not addressed.

9. Collinearity

Billing Regression Analysis of Net-to-Gross Ratio
Multi-collinearity was not a significant problem in this analysis. The procedures used to detect it are described in Chapter XII.

Billing Regression Analysis of Gross Impacts
Multi-collinearity was not a significant problem in this analysis. The procedures used to detect it are described in Chapter XII.

Discrete Choice Analysis of Net-to-Gross Ratio
Multi-collinearity was a significant problem in this analysis and contributed to the instability of the model. The problem appears to be intractable in this analysis. The procedures used to detect it are described in Chapter XII.

10. Influential Data Points

Billing Regression Analysis of Net-to-Gross Ratio
Two influential data points were identified and removed from the analysis. The method of detection and the rationale are described in Chapter XII. Another outlier was detected in the non-energy-using model, but was not removed because the parameter estimates were not affected.

Billing Regression Analysis of Gross Impacts
Customers with 1 or more DFFITS values greater than 1.0 were identified. Their weights were reduced by 1/4 to mitigate their influence without removing them from the model.

Discrete Choice Analysis of Net-to-Gross Ratio
N/A

11. Missing Data

Billing Regression Analysis of Net-to-Gross Ratio
Sample elements that had missing data on significant proportions of billing data were dropped from the analysis. Where there were isolated missing months a mean of the contiguous months was placed in the missing one. Missing data for cooled square footage was replaced with the mean value for that building type.

Billing Regression Analysis of Gross Impacts
Sample elements that had missing data on significant proportions of billing data were dropped from the analysis. Where there were isolated missing months a mean of the contiguous months was placed in the missing one. Missing data for cooled square footage was replaced with the mean value for that building type.

Discrete Choice Analysis of Net-to-Gross Ratio
Missing data for cooled square footage was replaced with the mean value for that building type.

12. Precision

Billing Regression Analysis of Net-to-Gross Ratio
The methods of calculating standard errors for all estimates are described in Chapter IX.

Billing Regression Analysis of Gross Impacts
The methods of calculating standard errors for all estimates are described in Chapter VI.

Discrete Choice Analysis of Net-to-Gross Ratio
The methods of calculating standard errors for all estimates are described in Chapter VIII.

E. Data Interpretation and Application

Total net program savings was calculated by multiplying the program database savings by the realization rate of 0.92, produced by the gross impacts analysis, and multiplying this adjusted gross savings by the net-to-gross ratio. The net-to-gross ratio was calculated by dividing the premise-level net savings generated by the net impact analysis, by the program database gross savings adjusted by the 0.92 realization rate.

APPENDIX C

Data Extraction and Master Statistical Analysis File Construction

Appendix C

Data Extraction and Master Statistical Analysis File Construction

A master statistical analysis file (MSAF) was constructed to serve as the basis for all other files used in the statistical analysis of gross savings and NTG ratios. This was done so that there would be consistent definitions of key variables and consistent methods of handling missing data, and basic recoding of variables. Each of the analyses for gross and net impacts involved variations on the master analysis file (MSAF), making whatever additional changes to the data as seemed analytically necessary. These subsequent changes to the MSAF are of course also documented in the appropriate sections of this report. The purpose of this Appendix is to describe the process of constructing the MSAF.

C.1 Objectives

The construction of the MSAF had four primary objectives:

1. To identify all the control numbers at a *customer location* as well as any affected control numbers associated with *adjacent businesses*. We define a customer location as the common sense notion of a customer such as a particular Long's drug store at a specific address or a particular McDonald's at a specific address. A customer location may have more than one meter and control number at this location. It is important to note that in some cases, the meters affected can extend beyond the customer location. This can happen in some special circumstances such as a shopping mall where, for example, reflective window film is installed that affects the air conditioners of adjacent tenants. The challenge was to aggregate the consumption at the customer location and when necessary to include the consumption from affected adjacent tenant spaces.

2. To clean the kWh data at the control number level to repair flaws or, in some cases, to eliminate control numbers which are irreparably flawed.

3. To aggregate kWh data to the premise level.

4. To combine the observed kWh data with other data relevant to planned analyses, the Program Data base data, the on-site survey data, and the telephone survey data.

C.2 Data Sets Used

Data extraction involved the use of seven data sets:

1. PG&E demographic file (DEMOG)
2. PG&E billing file (BILLING)
3. PG&E Program Data base (DATA BASE)
4. economic data (ECON)
5. telephone survey data (SURVEY)
6. weather data (WEATHER)
7. on-site data (ONSITE).

Table C-1 below lists the key variables in each file.

Table C-1: Data Used to Construct Regression Analysis Files

DEMOG DATA	BILLING DATA	PROGRAM DATA BASE	ECONOMIC DATA	TELEPHONE SURVEY DATA	WEATHER DATA	ONSITE DATA
Control number	Control number	Seed Control Number	Employment in Commercial Sector by MSA	Equipment Installations Outside the Program	25 PG&E Weather Stations (CDD & HDD)	Meter number
Account number	Account number	PG&E Savings Estimate	Average Monthly kWh Consumption Per Premise Per SIC per CEC climate zone	What Participants Would Have Purchased in Absence of Program	NOAA TMY Weather Data	Enhanced Savings Estimate
Meter number	Month/Year	Installation Date	Real Per Capita Personal Income By MSA	Changes in Business Hours & Square Footage		
Name of Company	kWh Consumption	Measure Code	California Taxable Sales	Seed Control Number		
Service Address	Premise ID					
SIC						

DEMOG is a data base with 953,079 observations and contains current information on all non- residential customers. It represents a snapshot of the active accounts and their related control numbers. Information includes service address, mailing address, the name of the company, the type of business being conducted, the meter number, the control number, and the account number. No historical information is included. This file is the only PG&E file that contains the meter number.

BILLING is a historical data base, maintained by PG&E's Rates Department, that contains the kWh consumption data in monthly frequency. PG&E produces this file by converting the billing data from a billing period frequency to a monthly frequency. This data base is organized such that there is one separate file for each year. Monthly consumption data were necessary since we planned to conduct the regression analyses at the premise level. This, in turn, meant that if there were more than two control numbers at a given premise each on a different billing cycle, they had to be converted to the same monthly frequency in order to be aggregated. Data are available for the period January 1992 through September 1995.

ONSITE contains meter numbers for 139 participants. It also contains the enhanced engineering-based estimates of savings and the seed control number. This file contains 281 observations, each representing a unique meter number associated with a unique control number.

DATA BASE contains information on program participants regarding what measure(s) were installed, various dates that allow the construction of the installation date, the PG&E estimate(s) of the expected savings associated with the installed measure(s), and the estimate of the control number affected. Program participation data for 1992, 1993, and 1995 were also provided for all 900 participants and non-participants.

ECONOMIC contains a variety of economic data for the period January 1992 through September 1995. These data were provided by PG&E which subscribes to the Data Resources, Inc. (DRI) who provides various quarterly economic data for metropolitan statistical areas (MSA) within the PG&E service territory. These quarterly economic data include:

- real per capita personal income
- employment in finance
- employment in trade
- employment in services

Also provided are the following state-level economic data:

- California taxable sales
- California consumer price index

PG&E also provided the average per-premise monthly kWh consumption within each of the CEC climate zones for the same 45-month period for each SIC code represented in the pool of 900 participants and non-participants.

WEATHER contains cooling and heating degree days (CDD and HDD respectively) in daily frequency from 33 PG&E-maintained weather stations scattered strategically throughout the PG&E service territory. Data are for January 1992 through September 1995. PG&E also matched these weather data to PG&E

local offices, which served as a link to customer billing data. CDDs and HDDs were calculated using the following base temperatures:

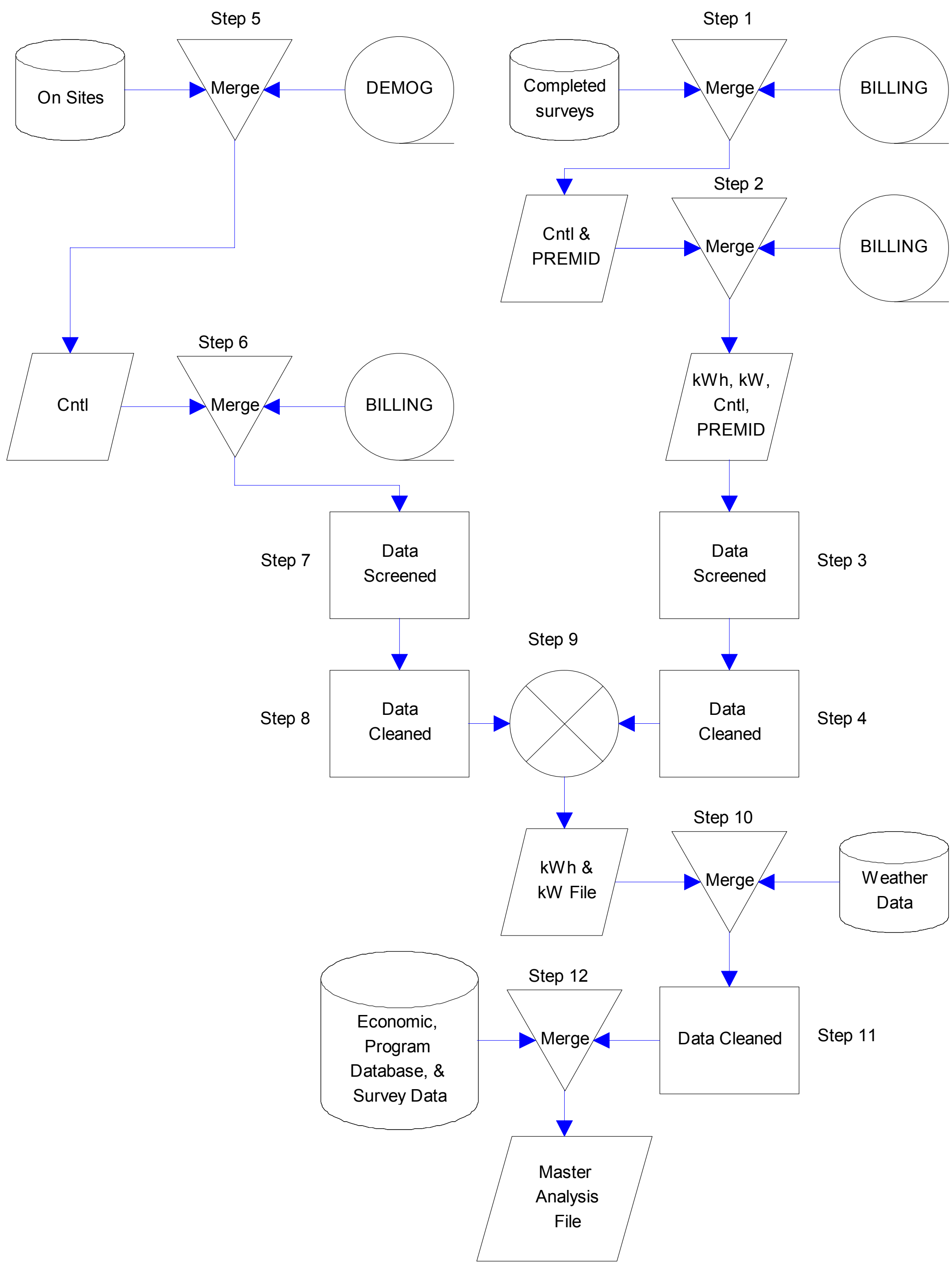
- cooling degree days: balance point temperature 55
- cooling degree days: balance point temperature 60
- cooling degree days: balance point temperature 65
- cooling degree days: balance point temperature 70
- cooling degree days: balance point temperature 75
- heating degree days: balance point temperature 50
- heating degree days: balance point temperature 55
- heating degree days: balance point temperature 60
- heating degree days: balance point temperature 65
- heating degree days: balance point temperature 70

This analysis did not examine the effect of relative humidity or solar radiation on electricity consumption.

Each building type was assigned the most appropriate CDD and HDD using the following mapping of temperature set points to building type:

- Large Offices 60 Deg. F
- Small Offices 65 Deg. F
- Restaurants 65 Deg. F
- Large Retail Stores 60 Deg. F
- Small Retail Stores 65 Deg. F
- Food Stores 70 Deg. F
- Refrigerated Warehouses 70 Deg. F
- Non Refrigerated Warehouses 70 Deg. F
- Elementary and Secondary Schools 65 Deg. F
- Colleges and Universities 65 Deg. F
- Hospitals 60 Deg. F
- Health Clinics 65 Deg. F
- Hotels and Motels 70 Deg. F
- Miscellaneous Commercial 70 Deg. F

Figure C-1: Master Analysis File Construction



Finally, whether retail or offices were classified as large or small was determined by calculating their average maximum per billing period demand for 1994. If the average was greater than 500 kW, they were classified as large. Otherwise, they were classified as small.

SURVEY contains data collected via telephone interviews for 450 participants and 450 non-participants. Data collected included equipment installations outside the program for both groups, changes in square footage and business hours, information about whether they paid their own electricity bill, and whether they owned or rented their space. Annotated versions of the two questionnaires are contained in Appendix A.

C.3 The Process of Data Extraction and MAF Construction

There were numerous steps involved in the extraction of the participant billing data. Here we will highlight some of the key steps graphically illustrated in Figure C-1.

Step 1

The first step involved merging by the seed control numbers in the Program Data base surveys with BILLING. These seed control numbers were the ones that were the basis of inclusion in the sample and that were associated with the 900 completed participant and non-participant telephone surveys. This merge resulted in 899 matches and 1 non-match which was due to the fact that the customer was no longer in business. The objective of this merge was to obtain the PREMID associated with each of these seed control numbers.

Step 2

These 899 matches were then merged again with BILLING but this time by PREMID in order to extract the monthly kWh and other data associated with all the control numbers linked to each PREMID. This resulted in bringing in an additional 711 control numbers beyond the original 899.

Step 3

Next, these data were subjected to a thorough account matching procedure. Account matching is the name commonly used to describe the process of reliably identifying all the control numbers and their associated kWh consumption for both program participants and non-participants. "Participants" and "non-participants" are understood to mean *customer locations*. We define location as the common sense notion of a customer such as a particular Long's drug store at a specific address or a particular McDonald's at a specific address. A customer location may have more than one meter and control number at this location. However, for this study, since we cannot in all cases reliably know which meter or meters were affected by an installation, we have chosen to aggregate the consumption for all meters at each customer location. It is important to note that in some cases, the meters affected can extend beyond the customer location. This can happen in some special circumstances such as a shopping mall where, for example, reflective window film is installed that affects the air conditioners of adjacent tenants. The challenge was to aggregate the consumption at the customer location and when necessary to include the consumption from affected adjacent tenant spaces. In the case of commercial chains, the *customer* is defined as the corporation such as the Long's Drug Store Corporation or the McDonald's Corporation. But, the customer location is the specific Long's Drug Store or McDonald's at a specific service address.

To repeat, our main objective is to identify all the control numbers at a *customer location* as well as any adjacent control numbers. We *do not* want to include any control numbers associated with other customer locations that may be associated with a *customer* such as multiple stores of the Safeway Supermarket Corporation.

The Chosen Approach. We attempted several approaches to aggregate the consumption data to the appropriate level. We will begin by describing the method we chose and then proceed to discuss those we rejected. We began with steps 1 and 2 already described above which extracted all control numbers associated with the participant and non-participant PREMIDs. This merge could have brought in two control numbers associated with the Acme Garage at a specific service address. Or, this merge could have brought in not just the control numbers associated with a particular Fresno City government building at a specific service address, i.e., customer location, but all the control numbers associated with all the buildings that were a part of the Fresno City government. This merge brought in a total of 1,610 control numbers. This file was then screened to eliminate control numbers that were clearly not a part of the same physical customer location thus reducing the file to 1,055. This means that on average there are nearly 1.2 meters per customer location, a number that, based on our experience, is entirely plausible.

The screening to reduce the file from 1,610 to 1,055 was done by visual inspection of the 1,610 control numbers associated with each of the 900 participant and non-participant premises since no computer program could be trusted always to make the right decisions. (We discuss this decision in more detail later in this section.) Instead, we developed two screening rules that were then applied systematically throughout the 1,610. These rules were:

1. If there was an exact match on name (NAME and NAME2) and service address (SERADDR, SERADDR2, CITY and ZIP) between the original control number (seed control) for the participants and non-participants and the potentially-included one, then the control number(s) was included if the total number of control numbers brought in by this match would be five or less. Here, an important tradeoff was made. If there were more than five control numbers, then we used *only* the seed control number. We had two reasons for doing this. Our first concern was that the summation of the kWh consumption for a customer location would make the savings a smaller fraction of the total consumption and thus make it more difficult to identify any savings as statistically significant in a regression model. In addition, when there were more than five control numbers, we suspected that there were multiple buildings involved even though there was a match on name and service address. The risk of course is that the seed control number may not be the one affected by any installations. For participants, this risk was present in spite of the fact that the seed control number was identified in the Program Data base as being connected to the affected meter. In such a cases, we chose to trust the PG&E program implementors. It is worth noting that such situations in which there were more than five control numbers potentially included were very rare.

2. If there was a *near* match on name (NAME and NAME2) and service address (SERADDR, SERADDR2, CITY and ZIP), then the control number was included if the total number of control numbers brought in by this match was five or less. A near match involved some judgment about abbreviations and the position of various parts of the name and address. In other words, the near match was taken into the sample only if it truly seemed to represent the same address.

Other Approaches Considered . For those customer locations that received on site visits, we were in a position to have essentially perfect information regarding the meters and control numbers associated with a given customer location as well as any adjacent meters and control numbers. For the 139 sites, there is an average of 2 meters per site. For 60 of the 139 on sites, we identified an additional 27 meters and control numbers beyond the initial control numbers contained in the Program Data base. How well we did in identifying all these additional 27 control numbers was the yardstick we used in evaluating the effectiveness of the various alternative account matching routines.

We tested various merge strategies and compared the results against this yardstick. We began with the 900 customer locations associated with completed telephone interviews and their associated names and service addresses. We then merged this file with the DEMOG file using various merge strategies to determine how many matches in total were obtained and how many of the 27 control numbers, that we know from on-site surveys should be associated with the seed control numbers, were identified. Table C-2 presents the results of three merge strategies. Each merge strategy is defined by the variables used to merge with DEMOG.

Table C-2: Comparison of Accounting Matching Routines

Merge Variables	Total Matches Obtained	Number of 87 Obtained
1. PREMID	1,610	13
2. NAME & SERVICE ADDRESS	3,544	5
3. NAME & ZIP CODE	6,111	18

The first merge by PREMID identified 1,610 control numbers and each successive merge essentially doubled the number of matches. The PREMID merge identified 13 of the 27 control numbers (there were 14 non-matches). Recall that earlier we had painstakingly identified all the control numbers at the 60 cluster sites including these 14 not matched by the PREMID merge method and thus we obtained all kWh data for all control numbers at these sites. Of these 14, 10 had a different PREMID but had the same exact service address and 4 were associated with an adjacent premise. However, if the result of this merge by PREMID which produced the 10 non-matches with on-site locations represents the number of control numbers that will not be identified by merging control numbers at the other 761 participant and non-participant customer locations with BILLING using PREMID, then we expect that 17% of the customer locations will be missing some control numbers. To the extent that the affected control numbers are among these missing control numbers our analysis will be compromised.

One of the things that we observed when performing this first match was the extent to which there was a great deal of standardization with respect to the spelling of name and service address. Based on this observation we attempted several other merge strategies. The NAME and SERVICE ADDRESS merge identified only 5 of the 27. Next, the NAME and ZIP CODE merge identified 18 of the 27. An examination of the non-matches associated with these two strategies, revealed the variability of customer name with respect to spelling, abbreviations, and word positions. We concluded that when two control numbers at a given customer location manifested any such variability, it would be virtually impossible to write computer code to reliably identify all the control numbers at a given customer location. This basically confirmed that the merges using PREMID or combination of NAME, SERVICE ADDRESS, and ZIP CODE augmented by visual inspection was the most inclusive way to proceed.

After rejecting the NAME and SERVICE ADDRESS merge strategy, the choice became whether we were better off using the results of the PREMID merge or the NAME and ZIP CODE merge. The NAME and ZIP CODE identified 5 more of the 27 controls but also brought in over three times the number of control numbers. We came to this conclusion by examining a sample of the non-matches when we attempted to match on customer name. The first thing we observed was that the danger posed by the NAME and ZIP CODE merge was the possibility that we would inadvertently add in control numbers that while matching on name and service address were not physically attached to the participant and non-participant customer locations. We hypothesized that to apply the same rules used to screen the 1,610 to the 6,111 would eventually produce a file certainly larger by some unknown magnitude than the 1,055 while running the risk of adding unrelated control numbers. Ultimately, we decided that adding five more of the 27 control numbers was not worth this risk.

Step 4

Next, this file was cleaned to eliminate control numbers with faulty data. When they converted from billing cycle to monthly frequency, PG&E's Rates Department had already addressed a number of common problems. They had repaired cases which had negative values as well as those cases in which there was overlap in the billing periods. There were two remaining problems which we addressed: 1) control numbers for which the average consumption was zero for the entire period, and 2) control numbers which manifested occasional zeroes in their stream of consumption data. The first problem was dealt with rather easily by simply eliminating those controls with average consumption of zero.

The second problem was not very serious to begin with since very few control numbers has either leading, trailing, or embedded zeros. For these, we interpolated across legitimate values. We also developed flags that indicated the extent to which any interpolation occurred at each premise so that any effects that they may have on any particular model could be easily identified.

Steps 5 through 8 warrant a brief introduction. The main purpose of these steps was to identify control numbers associated with the 139 on-site surveys that may not have been identified in Step 2. There are two ways that new control numbers could be brought in through this route: 1) a second PREMID had been assigned to a control number at the customer location, or 2) a control number was associated with an adjacent tenant space was found to be affected which, of course, involved a different PREMID.

Step 5

The 281 unique meters associated with the 139 sites were first merged with DEMOG to identify the associated control numbers. This merge produced a total of 263 control numbers along with names and service addresses.

Step 6

Next, these 263 control numbers were merged with BILLING to extract the monthly kWh and PREMID.

Step 7

These data were then subjected to the same accounting routine described in Step 3. This exercise produced the following results. For 138 (53%) of these 263, an additional control number was identified that was affected by the equipment installations. Of course, for the 311 participant customer locations not receiving on sites and the 450 non-participant customer locations not receiving on sites, we did not have any information about such adjacent tenant spaces that might have been affected by any installations.

Of these 138 for which additional control numbers were found, 112 also involved a different PREMID. Of these 112, 19, while having a different PREMID, were associated with the same premise identified in the Program Data base. This is the case, even though to assign a different PREMID to control numbers at the same customer location is contrary to PG&E policy. Thus, merging by the PREMID associated with our seed control number will miss these other control numbers since they have a different PREMID. Based on these on-site survey this means that, when merging with BILLING by PREMID, approximately

11% (19/(45 + (263-138) of the control numbers associated with those customers not receiving on-site surveys will not have been identified. The remaining 93 of the 112 were associated with a different premise associated with an adjacent tenant. Only on-site surveys can ever identify adjacent tenants and their PREMIDs for all participants and non-participants, an approach which is prohibitively expensive.

To the extent that we could not identify adjacent control numbers or participant and non-participant control numbers that had been assigned a different PREMID, our realization rates may be slightly lower than they should be.

This exercise (Step 5 through 8) added 119 control numbers that had not been identified in Step 2.

Step 8

Next, these data were subjected to the same cleaning routines described in Step 4.

Step 9

The data produced in Steps 4 and 9 were then concatenated to form one data set.

Step 10

The weather data from the 25 PG&E weather stations and the typical meteorological year (TMY) weather data from the National Oceanographic and Atmospheric Administration (NOAA) were then merged with the billing data produced in Step 9. The data from the 25 PG&E weather stations were merged with the monthly kWh data, using the PG&E local office identifier that linked each premise with the data from appropriate weather station. The TMY data were linked to the CEC climate zones and each premise was mapped into one of these CEC climate zones thus allowing TMY data to be appropriately matched to the kWh data for each premise.

Step 11

Two activities took place in Step 11. The first was to review the situations in which there was a change in the SIC code status for a given location over time that might contaminate a given stream of consumption to the point that it was unusable. The second involved cases in which there was more than one control number linked to a given premise. In such a situation, the task was to aggregate the consumption across the linked control numbers in a defensible manner.

SIC Code Changes. Before describing these activities, recall that the sample of participant interviewees was selected based on the presence of billing data associated with the control number in the Program Data base for 12 months prior to the installation of the efficient equipment and for the post installation period through the most recent month for which billing data were available. The sample of non-participant interviewees was selected based on the presence of billing data associated with commercial control numbers in the DEMOG file for all of 1993 through the most recent month for which billing data were available. These two samples were drawn in March and June of 1995 respectively.

We can now begin a description of the first activity. The billing data through September 1995 could not be extracted from the PG&E billing system until October/November, 1995. The delay between the original sampling and the follow-up data extraction provided an opportunity for changes to occur in the businesses in the sample. The analysis team was concerned that, if a sample business moved from the premises and another, different type of business moved in during the evaluation period, the consumption could be changed dramatically, not because of the effects of energy efficient equipment, but because of the change in consumption patterns.

To detect such situations, the achieved interview samples of participant and non-participant control numbers were merged with the 1995 PG&E DEMOG file to identify changes in business name between 1994 and 1995. Eleven name changes were detected and examined. Upon review of the eleven sites it became clear that some of those changes did not represent actual changes in occupants or business activities. Therefore, two principles were developed to serve as the basis for decisions on which cases would be retained in the sample and which would be removed.

The principles were as follows:

1. To be dropped, a clear change would have to be noted in the occupant. Many changes appeared to be no more than changes in property managers or building owners. It was not always possible to determine, however, which names reflected property managers, which reflected building owners and which reflected tenants. However, because of the prevalence of property manager and owner changes, we required a clear indication that the tenant occupant change to qualify for being dropped from the sample.

2. Where the business that showed some change was part of a multi-business building, the case was not dropped even when there was an apparent change in occupant for a particular shopping center bay. This decision was made based on the fact that all meters in a shopping center were aggregated for the billing analysis since the HVAC installations usually affect all businesses in the center. The assignment of a control number to the project would necessarily often be arbitrary since the measure generally applies to the building, not one business. In these situations, a change in one of the multiple tenants would not likely be noticeable in the consumption patterns of the aggregate. Also, in such situations, changes in occupancy will be common over a three or four year period. Deleting the building in response to these types of changes would result in few or no remaining shopping centers in the sample.

Applying these principles to the cases where a name change occurred between 1992 and 1995 resulted in one case being dropped from the sample.

In the course of creating final data sets, a second type of change across time was noted. This was an unexpected type of change as it goes against our understanding of PG&E policy. There were 105 situations where the control number remained constant but the premise number changed. When one such case appeared, a systematic search for others like it was made, and the results inspected to determine the possible occupancy changes that may have accompanied them. Careful inspection of names and addresses of the businesses involved in premise number changes was conducted using the same two principles listed above. This process resulted in removing 11 cases from the sample. Another 19 cases showed changes that would have qualified them to be dropped except that the changes occurred between 1992 and 1993. In this situation the case was retained but the 1992 data were removed. Losing the 1992 data still allowed for a full 12 months of billing data prior to a 1994 installation.

In summary, a total of 12 cases were removed from the sample; one because of a change in occupant in a single-business building, although the control number and premise number remained the same. Eleven cases were dropped because a change in premise number seemed to reflect a similar type of change in occupancy. Of the 12 removed cases, six were participants and six were non-participants.

Data Aggregation. We investigated several rules for aggregating consumption at the premise level and decided on the one described here. First, we assumed that the control number, the one found in DATA

BASE, was the primary control number and all other control numbers were viewed in terms of whether they could be aggregated with it. Second, the other control number(s) was included in the aggregation only if it started its non-missing consumption within the same calendar year as the main control number *and* this start date was no later than 5 months after the commencement of the non-missing consumption data for the main control number. Additionally, this other control number(s) must have non-missing consumption data through within two months of the last consumption date for the main control number. If the control number(s) met these requirements, it was included in the aggregation for all months for which there is consumption for the main control number. Having said this, the application of this rule ultimately eliminated only 19 secondary control numbers across all participant and non-participant control numbers.

Step 12

Finally, the premise-level kWh data were merged with telephone survey data, the economic data, and the data from the Program Data base to form the MSAF.

APPENDIX D

Analysis of Attrition Bias

Appendix D
Analysis of Attrition Bias

Appendix C described the process of building the master statistical analysis file (MSAF). This section describes in more detail the attrition from the sample that took place at each stage. In addition, this section describes the results of analyses that attempted to identify any bias stemming from this attrition.

D.1 Introduction

In any data collection effort there are non respondents -- those who were selected to be in the sample but are either unavailable or unwilling to respond, or are unfit for a variety of reasons having to do with the quality and/or quantity of their kWh data. These non-respondents are often not representative with respect to the variable of interest. In such a situation, the sample mean of the respondents would be biased as an estimate of the population parameters. Beginning with the creation of the sample frames for both the participants and the non-participants, attrition has taken place for a variety of reasons, possibly affecting the representativeness of the achieved samples of 450 participant and 450 non-participant respondents to the telephone surveys.

Figures D-1 and D-2 present the stages in the process of moving from the participant and non-participant sample frames to the achieved samples. At each step, the number of cases surviving is indicated. In the sections below, the reasons for attrition will be briefly discussed followed by the presentation of the results of the analyses to determine if the attrition resulted in achieved samples of participants and non-participants which are no longer representative of their respective populations.

D.2 Participant Group Attrition

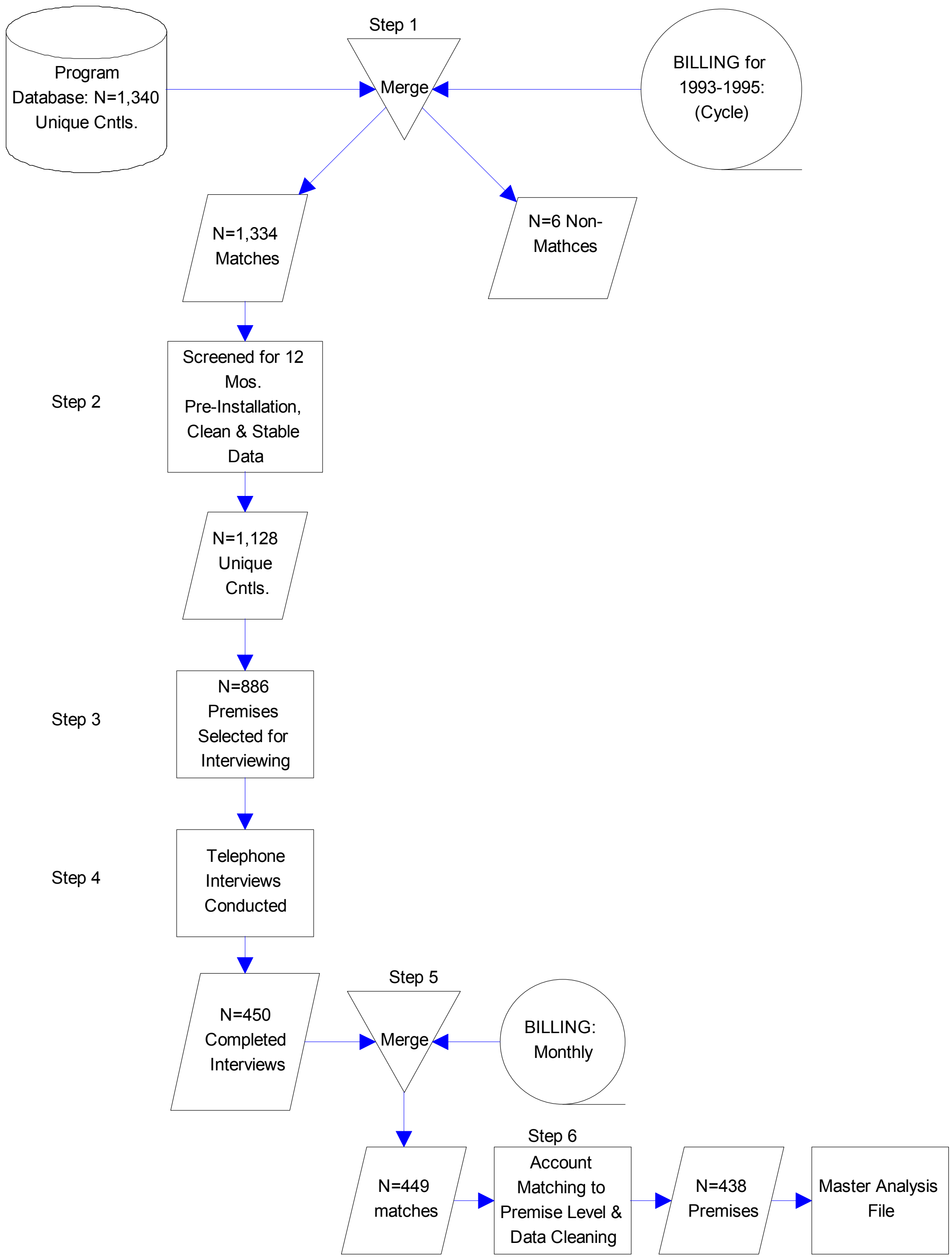
For participants, there are four steps in the process during which bias could have been introduced.

1. We began with a sample frame of 1,340 unique control numbers[1] that were located in the Program Data base. These control numbers are associated with 2,002 items installed. In step 1, of these 1,340, we found matches for 1,334 with the BILLING file. Thus, 6 control numbers were lost in the process in Step 1.

2. For these 1,334 matches, we identified 1,128 control numbers which had an 12 months of pre-installation kWh consumption and had recorded consumption through the most current month available in the BILLING file. From these, 886 premises (a collection of control numbers associated with a single customer at a given service address) were selected into the pool for telephone interviewing. Thus, 206 control numbers were lost in Step 2.

Figure D-1: Attrition Experienced in Creation of Participant File

[1] This frame did not include the "Excluded Domain" comprised of 105 installations that had small savings estimates or were infrequently installed.


Program Database: N=1,340 Unique Cntls.
Step 1
Merge
BILLING for 1993-1995: (Cycle)
N=1,334 Matches
N=6 Non-Mathces
Step 2
Screened for 12 Mos. Pre-Installation, Clean & Stable Data
N=1,128 Unique Cntls.
Step 3
N=886 Premises Selected for Interviewing
Step 4
Telephone Interviews Conducted
N=450 Completed Interviews
Step 5
Merge
BILLING: Monthly
N=449 matches
Step 6
Account Matching to Premise Level & Data Cleaning
N=438 Premises
Master Analysis File

3. Of the 886 premises associated with the 1,128 control numbers, 450 premises completed the telephone interviews in Step 4. The details of the attrition experienced during the telephone interviewing, are described in more detail in Section III of this report.

4. The final stage, Step 6, eliminated 12 premises to yield 438 premises available in the MSAF. One was eliminated since it had inadequate post installation data. Another 6 were eliminated because their SIC2 codes changed over time (described in Appendix C) suggesting a significantly different consumption patters. Finally, due to confusion regarding the consolidation of related control numbers into premises prior to telephone interviewing, 4 premises completed two interviews and one premise completed both a participant and a non-participant interview. These five were thus eliminated.

With respect to the potential bias in Steps 1 and 2, we did not compare the kWh consumption of the 1,344 with to that of the 1,128. If not having enough pre or post kWh data means that the business is either new or has closed, then the 1,128 may very likely be different from the 1,344. Thus, we have taken the conservative approach of restricting our generalizations regarding program impacts to that subset of customers who have been active for more than 22 months.

The approach we chose to detect any bias in Step 4 involved a comparison of the 1,128 control numbers in the Program Data base with the 450 control numbers (originally from the Program Data base) associated with completed interviews. There are three critical variables on which these two groups are compared:

1. annual consumption for 1993,

2. building type[2], and

3. CEC climate zone.

Such a comparison can answer the question as to whether this attrition has resulted in an achieved sample that is no longer representative of the population of 1,128 control numbers.

We proceeded to test the null hypotheses that no significant differences exist between these two groups with respect to these three variables. We rejected the null hypotheses for critical values that were significant at the 5% level.

1. The first analysis involved an analysis of variance (ANOVA) which compared the two groups with respect to their 1993 annual kWh consumption within each of the 5 usage stratum defined below:

stratum 1	=	< 15,999
stratum 2	=	>= 15,999 and < 40,000
stratum 4	=	>= 102,081 and < 341,500
stratum 5	=	>= 341,500

[2] The translation of the SIC2 variable (the primary activity for the account) which is contained in BILLING is described in Appendix C.

A comparison within stratum is appropriate since the participant sample was more heavily weighted toward larger customers with larger savings and therefore larger consumption. Thus, the question was framed in such a way as to determine whether the respondents within a given usage stratum are representative of the larger population within the same usage stratum.

2. The second analysis compared within these 5 strata these two groups with respect to the same building types described in Appendix C and used a chi-square statistic or Fisher's exact[3] to determine statistical significance.

3. The third analysis compared within these 5 strata these two groups with respect to the CEC climate zones. This analysis also used a chi-square statistic or Fisher's exact to determine statistical significance.

The results of these three analyses are presented in Table D-1. For those cells for which it was impossible to conduct a test due to zero frequency for one of the two groups, N/A (not applicable), is inserted. Those comparisons that are statistically significant at the .05 level are shaded. As a result of these tests, we conclude that there is no evidence of significant non-response bias. Therefore, we may use the weighted data sets for the purpose of estimating both net and gross impacts.

Non-participant Group Attrition

For non participants, there are four steps in the process, shown in Figure D-2, during which bias could have been introduced.

1. The first is step 4 which examined the 20,400 non participant control numbers to determine if there were kWh data for all of 1993 through the most current month for which such data were available from BILLING. During this step, each of the 20,400 was also examined to determined if they had complete address, both service and billing addresses, and telephone number. This resulted in a loss of 3,952 control numbers.

2. The second opportunity for bias was in step 6 in which certain customers perceived by PG&E to be very sensitive to the intrusion posed by a telephone interview were intentionally eliminated from the non participant pool. Table D-2 presents the five reasons for eliminating customers from the non-participant pool and the number of customers in the HVAC non-participant pool affected.

    The fundamental question is whether the elimination of any of these 195 from the HVAC non-participant group would compromise the representativeness of the non-participant sample frame as we've defined it and thus compromise the integrity of the research design.

[3] When the expected frequency in a any given cell of a 2 X 2 table or a R X C table is less than 5, the Chi-Square test may not be a valid. When this occurs, Fisher's exact test is used in its place. (See, for example, Blalock, 1972).

Table D-1: Comparison of 450 Participant Respondents to 1,128 Participants Eligible for Contact

Stratum 1

Building Type	Chi-Square Probability	Fisher's Exact Probability
Non-Refrigerated Warehouse		1.00
Health Service	N/A	
Food Retail	N/A	
Hotel/Motel	N/A	
Refrigerated Warehouse	N/A	
Non-Food Retail		1.00
Personal Repair Service		1.00
Restaurant	N/A	
Office		0.73
Elementary/Secondary School		1.00
College/Vocational School		0.41
Community Service		1.00
Miscellaneous		0.32

CEC Climate Zone	Fisher's Exact Probability
	0.91

Group	N	Mean Annual kWh
P450	12	12,112
P1128	40	10,435

ANOVA Results		
F Value	N	Probability
1.86	52	0.18

Stratum 2

Building Type	Chi-Square Probability	Fisher's Exact Probability
Non-Refrigerated Warehouse		0.43
Health Service		1.00
Food Retail	N/A	
Hotel/Motel		0.41
Refrigerated Warehouse	N/A	
Non-Food Retail		0.73
Personal Repair Service		1.00
Restaurant		1.00
Office	0.68	
Elementary/Secondary School	N/A	
College/Vocational School		0.41
Community Service		0.52
Miscellaneous	0.93	

CEC Climate Zone	Fisher's Exact Probability
	0.69

Group	N	Mean Annual kWh
P450	35	25,966
P1128	116	27,293

ANOVA Results		
F Value	N	Probability
1.06	151	0.31

Stratum 3

Building Type	Chi-Square Probability	Fisher's Exact Probability
Non-Refrigerated Warehouse		0.34
Health Service		0.64
Food Retail		1.00
Hotel/Motel		1.00
Refrigerated Warehouse	N/A	
Non-Food Retail		0.68
Personal Repair Service		0.68
Restaurant		0.64
Office	0.66	
Elementary/Secondary School		0.47
College/Vocational School		1.00
Community Service	0.56	
Miscellaneous	0.47	

CEC Climate Zone	Fisher's Exact Probability
	0.69

Group	N	Mean Annual kWh
P450	59	70,906
P1128	180	67,387

ANOVA Results		
F Value	N	Probability
1.62	239	0.20

Stratum 4

Building Type	Chi-Square Probability	Fisher's Exact Probability
Non-Refrigerated Warehouse	0.88	
Health Service		0.70
Food Retail		0.70
Hotel/Motel	0.28	
Refrigerated Warehouse	N/A	
Non-Food Retail	0.77	
Personal Repair Service		0.66
Restaurant	0.48	
Office	0.36	
Elementary/Secondary School	0.61	
College/Vocational School		1.00
Community Service	0.44	
Miscellaneous	0.39	

CEC Climate Zone	Chi-Square Probability
	0.89

Group	N	Mean Annual kWh
P450	87	195,019
P1128	242	189,777

ANOVA Results		
F Value	N	Probability
0.4	329	0.53

Stratum 5

Building Type	Chi-Square Probability	Fisher's Exact Probability
Non-Refrigerated Warehouse	0.75	
Health Service	0.96	
Food Retail	0.72	
Hotel/Motel	0.44	
Refrigerated Warehouse	0.50	
Non-Food Retail	0.45	
Personal Repair Service		0.53
Restaurant	0.56	
Office	0.48	
Elementary/Secondary School	0.91	
College/Vocational School	0.16	
Community Service	0.41	
Miscellaneous	0.90	

CEC Climate Zone	Chi-Square Probability
	0.7

Group	N	Mean Annual kWh
P450	255	9,110,629
P1128	550	7,067,916

ANOVA Results		
F Value	N	Probability
0.78	805	0.38

Table D-2: Reasons for Eliminating Customers and Number Affected

Reason	Number Affected
Overlap with BCUS Survey	46
Overlap with the Lighting Retrofit non-participant pool	83
Overlap with the Lighting Retrofit participant pool	39
Sensitive customer	16
Bad data	11
Total	195

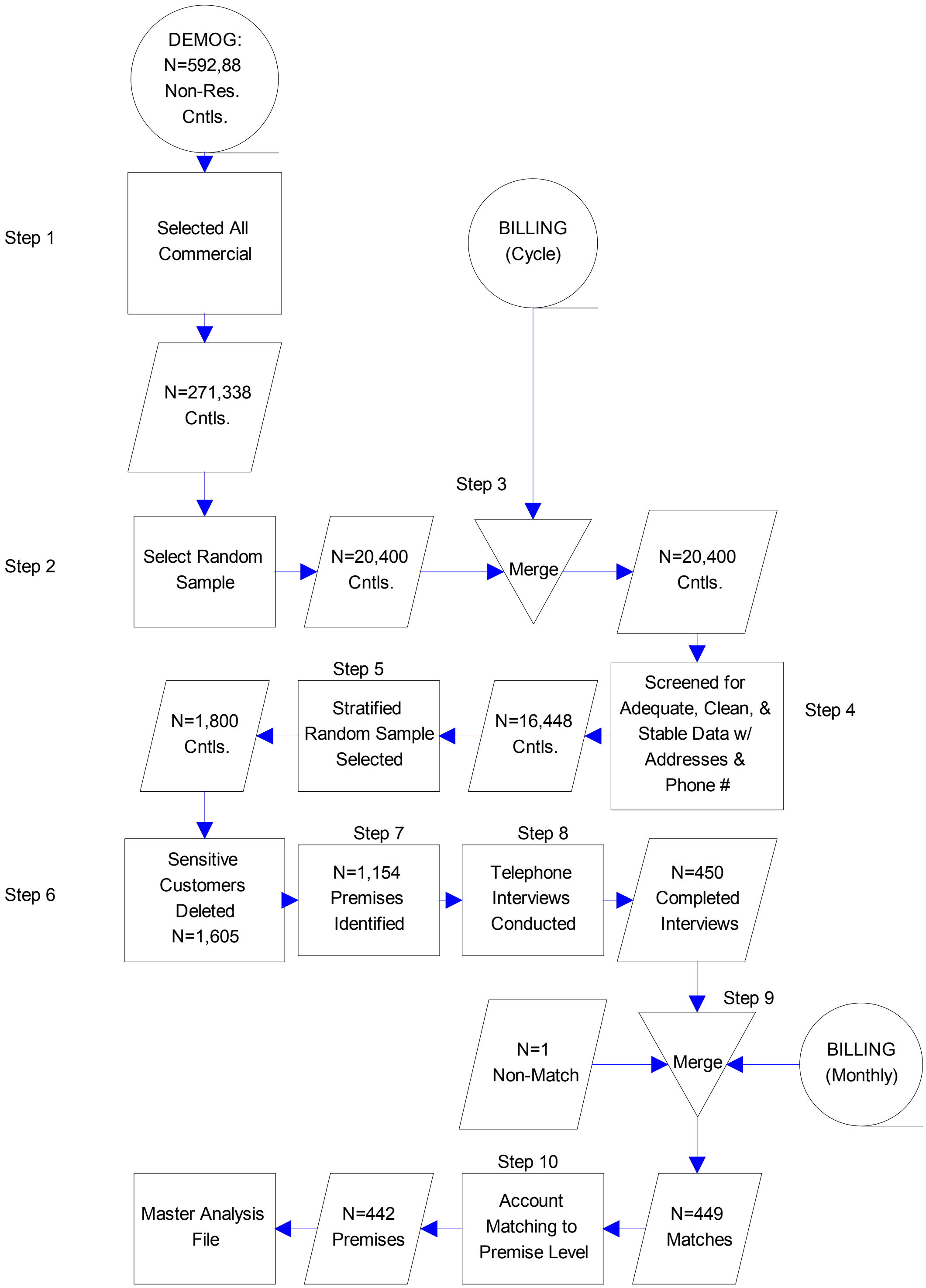
Our position is that, as a general rule, one can not legitimately eliminate from the non-participant pool any customers who participated in any other PG&E DSM program in 1995 or eliminate any customers who may have participated in the HVAC Retrofit or any other DSM program before or after 1994. This is consistent with our definition of a non-participant as one who, while not participating in the 1994 HVAC Retrofit Program, could participate in other PG&E programs in the same year or in any PG&E program before or after the program year, 1994. However, while we agree in general with this methodological position, we recognize that there are some situations in which the effect of eliminating some customers from the non-participant pool would either have no effect or a small effect at most.

To better understand such a situation, let's review each of the reasons for elimination. The first two were the BCUS and Lighting Retrofit *non-participant* surveys which were being conducted at the same time we were collecting data. Both of these surveys involved *random samples* from the pool of commercial customers. Recall that the pool of HVAC non-participants was also drawn *randomly* from the pool of all commercial customers who were eligible to participate in the HVAC Retrofit Program. As a result, it is hypothesized that the elimination of these 129 customers should not produce any systematic bias in the HVAC non-participant pool.

Since the commercial HVAC and Lighting Retrofit Programs are being evaluated as two separate programs, there was an overlap of 39 sampled participants in the Lighting Retrofit Program with both the sampled HVAC participants and non-participants[4]. By the time the overlap had been detected, the participant interviewing was nearly complete. However, the question arose as to whether these 39 Lighting participants should be excluded from the HVAC non-participant pool so as not to burden them with multiple contacts by the survey research firms hired to collect data to support the evaluations of these two programs. If their elimination would compromise the integrity of the evaluation design, then there would be no other option but to include them. In this case, there is the potential for such bias since this group is not a random draw from all commercial customers but rather the result of some process of self-selection into the Lighting Retrofit program.

[4] Note that in the HVAC non-participant pool, there was a total of 118 participants in the Lighting Retrofit Program. However, only 39 were sampled for use in the evaluation of the Lighting Retrofit Program. Thus, 79 participants in Lighting Retrofit Program remain in the HVAC non-participant pool.

Figure D-2. Attrition Experienced in Creation of Non-Participant File



With respect to the 16 customers who were considered too sensitive to be bothered by data collectors, there is the potential for bias since these customers may be some of the larger customers who may soon have the option of purchasing their electricity elsewhere.

Finally, it was hypothesized that the 9 customers who had bad data were the result of a random process. As a result, their elimination, it was hypothesized, should have little effect on the representativeness of the HVAC non-participant pool.

3. The third opportunity for bias was in step 8 during which certain customers were unwilling to participate in the telephone survey or were unreachable for a variety of reasons. The details of the attrition experienced during the telephone interviewing, are described in more detail in Section III of this report.

4. The final stage, Step 10, eliminated 8 premises to yield 442 premises available in the MSAF. First, 6 were eliminated because their SIC2 codes changed over time (described earlier) suggesting a significantly different consumption patterns. Finally, due to confusion regarding the consolidation of related control numbers into premises prior to telephone interviewing, one premise completed two interviews and one premise completed both a participant and a non-participant interview. These six were thus eliminated.

With respect to the first source of bias, we did not compare the kWh consumption of the 20,400 to that of the 16,448. If not having enough pre or post kWh data means that the business is either new or has closed, then this group may very likely be different from the 16,448. Thus, we have taken the conservative approach of restricting the our generalizations regarding program impacts to that subset of customers who have been active for more than 22 months.

We did examine the possibility of bias stemming from the second and third sources in Steps 6 and 8. The approach we chose to detect any bias involved two comparisons:

1. a comparison of the 1,800 control numbers and the 1,605 control numbers

2. a comparison of the 1,800 control numbers in the Program Data base with the 450 control numbers (originally from the Program Data base) associated with completed interviews.

Such comparisons can answer the questions as to whether the 1,605 are representative of the 1,800 and whether the 450 are representative of the 1,800. The same three variables on which the participants were compared are used here also. We again proceeded to test the null hypotheses, using the same tests described above, for participants, that no statistically significant differences exist between these groups with respect to these three variables. Again, we rejected the null hypotheses for critical values that were significant at the 5% level.

The results of the first analysis are that there are no statistically significant differences between the 1,605 and the 1,800 with respect to annual usage, building type, or CEC climate zones.

The results of the second analysis are presented in Table D-3. For those cells for which it was impossible to conduct a test due to zero frequency for one or both of the two groups, N/A (not applicable), is inserted. Those comparisons that are statistically significant at the .05 level are shaded. As one can see, with very few exceptions, there are that are no statistically significant differences between the 450 and the 1,800 with respect to annual usage, building type, or CEC climate zones. The only possible source of

bias stems from different distributions within Stratum 1 of the two groups with respect to offices and the CEC climate zones. This is not considered to be a serious bias especially in light of the fact that most of the savings occur in the larger strata. Therefore, we may use the weighted data sets for the purpose of estimating both net and gross impacts.

APPENDIX E

Statistical Gross Model Specifications and Diagnostics

Appendix E

Statistical Gross Model Specifications and Diagnostics

The purpose of this appendix is to provide further documentation of the analysis which led to the selection of a statistical model to use in estimating gross program savings. This appendix is presented in two parts. The first part provides descriptive statistics for the variables that were used in various model specifications. The second part provides model specifications and diagnostics for a series of models which were tested.

E.1 Descriptive Statistics for Model Variables

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Variable	Label	N	Minimum	Maximum	Mean	Std Dev
PREMID2	Premise ID	16742	11405.00	6110120.00	3290501.30	2093139.59
PERIOD	month designator, 1-45	16742	1.00	45.00	23.17	12.93
AGGSIC4	agg sic2 x cz kwh	16742	0.00	399598.72	63441.25	82418.33
AGGSIC4N	agg sic2 x cz, norm on mean	16742	0.00	283.77	101.27	21.15
AGGSIC3	agg sic3, territory	16742	0.00	2880390.00	152850.21	330291.04
AGGSIC2	agg sic2, territory	16742	0.00	2880390.00	549380.51	629358.78
ETOT	tot emp for mo, territory	16742	18.47	609.21	231.06	207.91
CDD	cdd at this btype setpoint	16742	0.00	790.00	93.67	146.93
CDDN	cddnorm at this btype setpoint	16742	0.00	673.50	75.27	126.09
CDDN2	cddn2 (adj) at this btype setpoint	16742	0.00	697.00	74.65	126.69
EHN94T	eval sae - hvac hn, 1994, mo. avg	16742	0.00	811482.00	1002.73	23697.69
EHN94S	eval sae - hvac hn, 1994, monthly	16742	-322.99	865793.65	1001.56	23570.67
EHN94U	eval sae - hvac hn, 1994, mo/denor	16742	-1776.34	865793.65	1013.85	23485.78
EHN94V	eval sae - hvac hn, 1994, mo. avg./denor	16742	0.00	811446.24	1012.36	23620.95
EHU94T	eval sae - hvac hu, 1994, mo. avg	16742	0.00	506869.41	696.78	14888.64
EHU94S	eval sae - hvac hu, 1994, monthly	16742	-4.75	523227.99	745.32	15080.86
EHU94U	eval sae - hvac hu, 1994, mo/denor	16742	-41094.84	523227.99	789.22	15183.95
EHU94V	eval sae - hvac hu, 1994, mo. avg./denor	16742	0.00	508937.05	733.67	14925.65
EUHN94T	eval up sae - hvac hn, 1994, mo. avg	16742	0.00	811482.00	1002.73	23697.69
EUHN94S	eval up sae - hvac hn, 1994, monthly	16742	-322.99	865793.65	1001.56	23570.67
EUHN94U	eval up sae - hvac hn, 1994, mo/denor	16742	-1776.34	865793.65	1013.85	23485.78
EUHN94V	eval up sae - hvac hn, 1994, mo. avg./de	16742	0.00	811446.24	1012.36	23620.95
EUHU94T	eval up sae - hvac hu, 1994, mo. avg	16742	0.00	506869.41	696.78	14888.64
EUHU94V	eval up sae - hvac hu, 1994, mo. avg./de	16742	0.00	508937.05	733.67	14925.65
PKHN94T	pkwh only, hvac hn, 1994, mo. avg	16742	0.00	43642.01	303.45	1813.91
PKHN94S	pkwh only, hvac hn, 1994, monthly	16742	0.00	15350558.81	35018.74	562456.04
PKHN94U	pkwh only, hvac hn, 1994, mo/denor	16742	-14.35	45001.63	312.66	1837.68
PKHN94V	pkwh only, hvac hn, 1994, mo. avg./denor	16742	0.00	43468.74	309.97	1831.58
PKHU94T	pkwh only, hvac hu, 1994, mo. avg	16742	0.00	36672.90	155.86	1443.36
PKHU94S	pkwh only, hvac hu, 1994, monthly	16742	0.00	15350558.81	27156.80	550685.23
PKHU94U	pkwh only, hvac hu, 1994, mo/denor	16742	0.00	143635.16	195.48	1901.75
PKHU94V	pkwh only, hvac hu, 1994, mo. avg./denor	16742	0.00	42070.70	183.85	1544.72
PKOT94T	pkwh only, othet, 1994, mo. avg	16742	0.00	4323.58	10.26	167.92
PKOT94S	pkwh only, othet, 1994, monthly	16742	0.00	4323.58	10.29	167.95
PKOT94U	pkwh only, othet, 1994, mo/denor	16742	0.00	4323.58	10.29	167.95
PKOT94V	pkwh only, othet, 1994, mo. avg./denor	16742	0.00	4323.58	10.26	167.92
EH94T	eval sae - hvac all, 1994, mo. avg	16742	0.00	811482.00	1699.51	27969.49
EH94S	eval sae - hvac all, 1994, monthly	16742	-322.99	865793.65	1747.82	27964.97
EH94U	eval sae - hvac all, 1994, mo/denor	16742	-41979.08	865793.65	1804.01	27944.90
EH94V	eval sae - hvac all, 1994, mo. avg./deno	16742	0.00	811446.24	1746.03	27919.38
EUH94T	eval up sae - hvac all, 1994, mo. avg	16742	0.00	811482.00	1699.51	27969.49
EUH94S	eval up sae - hvac all, 1994, monthly	16742	0.00	15350558.81	45916.71	600231.09
EUH94U	eval up sae - hvac all, 1994, mo/denor	16742	-41979.08	865793.65	1804.01	27944.90
EUH94V	eval up sae - hvac all, 1994, mo. avg./d	16742	0.00	811446.24	1746.03	27919.38
PKH94T	pkwh only, hvac all, 1994, mo. avg	16742	0.00	43642.01	459.31	2350.00
PKH94S	pkwh only, hvac all, 1994, monthly	16742	0.00	15350558.81	40388.51	567881.23
PKH94U	pkwh only, hvac all, 1994, mo/denor	16742	0.00	144529.17	527.13	2737.84
PKH94V	pkwh only, hvac all, 1994, mo. avg./deno	16742	0.00	43468.74	493.82	2426.35

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Variable	Label	N	Minimum	Maximum	Mean	Std Dev
PKL94T	pkwh only, lits all, 1994, mo. avg	16742	0.00	105583.33	605.14	4029.55
PKL94S	pkwh only, lits all, 1994, monthly	16742	0.00	15350558.81	41215.79	581223.60
PKL94U	pkwh only, lits all, 1994, mo/denor	16742	0.00	105583.33	662.51	4244.08
PKL94V	pkwh only, lits all, 1994, mo. avg./deno	16742	0.00	105583.33	605.14	4029.55
TRH94T	any trkg, hvac all, 1994, mo. avg	16742	0.00	1622964.00	3858.33	56045.33
TRH94S	any trkg, hvac all, 1994, monthly	16742	-645.97	1731587.30	4099.87	56246.77
TRH94U	any trkg, hvac all, 1994, mo/denor	16742	-83958.17	1731587.30	4255.37	56242.06
TRH94V	any trkg, hvac all, 1994, mo. avg./denor	16742	0.00	1622892.49	3985.88	55955.49
TRL94T	any trkg, lits all, 1994, mo. avg	16742	0.00	105583.33	605.14	4029.55
FLAGEV	KWH EV/KWHEV20 suspect	16742	0.00	1.00	0.29	0.45
MEANPRE	mean pre kwhmo	16742	240.55	15350558.81	172466.45	934135.49
SCHGHRS	chghrs* meanpre	16742	-65045793.08	24086405.00	-175906.02	3593135.13
SCHGSQF	chgsqf* meanpre	16742	-79858431.22	428497103983	1767792231.0	23741697275
SRCOOL	s.r. rep coolequip*meanpre	16742	0.00	182745.00	257.25	5836.71
SRCOOLE	s.r. effic cool equp * meanpre	16742	0.00	0.00	0.00	0.00
SFIXREP	s.r. fixture rep * meanpre	16742	0.00	183142652.47	985494.64	8642818.60
SLAMPRP	s.r. lamp rep * meanpre	16742	0.00	183142652.47	1986015.72	10345618.99
SACOOL	s.r. add coolequip*meanpre	16742	0.00	2520571.20	5115.31	82296.09
SACOOLE	s.r. add effcoolequp*meanpre	16742	0.00	130193.25	108.87	3763.40
SADDASD	s.r. add asd * meanpre	16742	0.00	2839714.16	6481.74	115476.01
SADTIM	s.r. add time clock * meanpre	16742	0.00	5730528.68	12914.68	244423.96
SADDHTG	s.r. add heatg equip* meanpre	16742	0.00	281326.91	738.03	12330.19
SREMLI	s.r. remove lights * meanpre	16742	0.00	585459.37	1707.80	25797.70
SADDSET	s.r. add setback therm * meanpre	16742	0.00	0.00	0.00	0.00
HDD60	heating degree days, base 60	16742	0.00	584.00	101.24	140.28
RWT3A	part 3a rel wt	16742	0.40	3.71	1.02	0.51
PROKWH2	prokwh under aggreg status 2	16742	0.25	16797682.75	169079.24	897337.59
POST1	flags first hvac measure install	16742	0.00	1.00	0.34	0.47
CDDHI	cdd/mo gt 245	16742	0.00	1.00	0.15	0.36
CDDHEU	cdd > 245 * SBW hvac prior	16742	0.00	811446.24	238.29	10950.01
CDDHPK	cdd > 245 * PGE hvac prior	16742	0.00	43209.37	57.94	793.24
GLM_MEAN	constant term from GLM warmup	16742	300.81	14391785.44	169083.76	891026.18
EUHN94D	dummy, sbw sample hvac non energy	16742	0.00	1.00	0.05	0.22
EUHU94D	dummy, sbw sample hvac energy usg	16742	0.00	1.00	0.05	0.21
PKHN94D	dummy, PGE hvac non energy	16742	0.00	1.00	0.20	0.40
PKHU94D	dummy, PGE hvac energy usg	16742	0.00	1.00	0.11	0.31
TRL94D	dummy, PGE tracking system lighting	16742	0.00	1.00	0.10	0.30
EUH94D	dummy, sbw sample hvac	16742	0.00	1.00	0.09	0.29
PKH94D	dummy, PGE hvac	16742	0.00	1.00	0.27	0.45
PKL94D	dummy, PGE lighting	16742	0.00	1.00	0.10	0.30
EUHN94L	dummy product, SBW hvac hn*lighting	16742	0.00	1.00	0.02	0.13
EUHU94L	dummy product, SBW hvac hu*lighting	16742	0.00	1.00	0.02	0.14
PKHN94L	dummy product, PGE hvac hn*lighting	16742	0.00	1.00	0.05	0.23
PKHU94L	dummy product, PGE hvac hu*lighting	16742	0.00	1.00	0.03	0.16
EUH94L	dummy product, SBW hvac *lighting	16742	0.00	1.00	0.03	0.18
PKH94L	dummy product, PGE hvac lighting	16742	0.00	1.00	0.07	0.26
EUHN94X	product, SBW hvac hn* lighting prior	16742	0.00	33682.22	173.77	1843.79
EUHU94X	product, SBW hvac hu * lighting prior	16742	0.00	105583.33	249.93	3315.90

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Variable	Label	N	Minimum	Maximum	Mean	Std Dev
PKHN94X	product, PGE hvac hn* lighting prior	16742	0.00	44651.44	232.02	2077.10
PKHU94X	product, PGE hvac hu * lighting prior	16742	0.00	44651.44	169.46	1750.41
EUH94X	product, SBW hvac*lighting prior	16742	0.00	105583.33	379.96	3667.23
PKH94X	product, PGE hvac*lighting prior	16742	0.00	44651.44	310.97	2291.34
EUHN94C	product, SBW hvac hn*cooling degrees	16742	0.00	647.00	4.14	34.06
EUHU94C	product, SBW hvac hu*cooling degrees	16742	0.00	781.00	5.57	45.05
PKHN94C	product, PGE hvac hn*cooling degrees	16742	0.00	647.00	17.69	70.35
PKHU94C	product, PGE hvac hu*cooling degrees	16742	0.00	647.00	14.01	69.79
EUH94C		16742	0.00	781.00	9.10	54.45
PKH94C		16742	0.00	647.00	27.10	89.59
PKL94C		16742	0.00	752.00	9.03	52.22
EUHN94N	product, SBW hvac hn *long run cdd	16742	0.00	495.00	3.39	28.86
EUHU94N	product, SBW hvac hu *long run cdd	16742	0.00	697.00	5.07	40.81
PKHN94N	product, PGE hvac hn *long run cdd	16742	0.00	542.00	14.21	58.86
PKHU94N	product, PGE hvac hu *long run cdd	16742	0.00	542.00	12.38	61.23
TRL94N		16742	0.00	697.00	7.66	46.16
EUH94N	product, SBW hvac *long run cdd	16742	0.00	697.00	7.87	47.99
PKH94N	product, PGE hvac *long run cdd	16742	0.00	542.00	22.63	76.91
RWTEV3A	part 3a rel wt, ev sample	4871	0.10	10.10	1.04	2.01
DROPKVR		16742	0.00	1.00	0.01	0.07

E.2 Model Specifications and Diagnostics

Shown below are the model specifications and diagnostics for a series of models which were tested.

TABLE 1 -- INFLUENCE DIAGNOSTICS: Model I26

Univariate Procedure

Variable=MAXDFIT

Moments Quantiles(Def=5)

N	376	Sum Wgts	376	100% Max	4.377923	99%	0.550027
Mean	0.053499	Sum	20.11544	75% Q3	0.024871	95%	0.126883
Std Dev	0.299711	Variance	0.089827	50% Med	0.011204	90%	0.063413
Skewness	11.98372	Kurtosis	154.6011	25% Q1	0.00503	10%	0.002428
USS	34.76112	CSS	33.68497	0% Min	0.000876	5%	0.001966
CV	560.2228	Std Mean	0.015456			1%	0.001372
T:Mean=0	3.461251	Pr>|T|	0.0006	Range	4.377047		
Num ^= 0	376	Num > 0	376	Q3-Q1	0.019842		
M(Sign)	188	Pr>=|M|	0.0001	Mode	0.000876		
Sgn Rank	35438	Pr>=|S|	0.0001				

Extremes

Lowest	Obs	Highest	Obs
0.000876(	206)	0.439326(	245)
0.00113(	226)	0.550027(	59)
0.001308(	162)	1.762102(	39)
0.001372(	311)	3.299503(	91)
0.001512(	285)	4.377923(	35)

Table 2 --- Multicollinearity diagnostics

Collinearity Diagnostics(intercept adjusted)

Number	Eigenvalue	Condition Index	Var Prop GLM_MEAN	Var Prop EUHU94D	Var Prop EUHN94D	Var Prop PKHU94D	Var Prop PKHN94D	Var Prop EUHU94C
1	3.26196	1.00000	0.0072	0.0075	0.0072	0.0132	0.0142	0.0074
2	2.07146	1.25488	0.0009	0.0394	0.0156	0.0048	0.0235	0.0403
3	1.77361	1.35616	0.0020	0.0262	0.0839	0.0043	0.0005	0.0337
4	1.62770	1.41564	0.0333	0.0041	0.0011	0.0525	0.0126	0.0002
5	1.34745	1.55590	0.0806	0.0060	0.0000	0.0344	0.0333	0.0188
6	1.21782	1.63662	0.0881	0.0047	0.0015	0.0223	0.0037	0.0016
7	1.03693	1.77364	0.0160	0.0008	0.0016	0.0000	0.0060	0.0065
8	0.99601	1.80971	0.0001	0.0004	0.0003	0.0003	0.0002	0.0004
9	0.80667	2.01091	0.2032	0.0008	0.0023	0.0120	0.0029	0.0198
10	0.70831	2.14599	0.4210	0.0001	0.0005	0.0091	0.0010	0.0045
11	0.67765	2.19400	0.0399	0.0049	0.0061	0.0070	0.0063	0.1690
12	0.61910	2.29540	0.0064	0.0011	0.0009	0.0013	0.0074	0.0088
13	0.57563	2.38051	0.0143	0.0016	0.0003	0.0403	0.0219	0.0006
14	0.55683	2.42034	0.0556	0.0025	0.0025	0.0012	0.0071	0.3736
15	0.47474	2.62127	0.0260	0.0090	0.0417	0.0919	0.0665	0.0122
16	0.36251	2.99972	0.0005	0.0149	0.7414	0.0642	0.0301	0.0018
17	0.32352	3.17531	0.0022	0.0019	0.0678	0.4335	0.0250	0.0116
18	0.28700	3.37130	0.0009	0.7985	0.0253	0.0052	0.0811	0.2376
19	0.27511	3.44337	0.0017	0.0755	0.0000	0.2024	0.6566	0.0515

Number	Var Prop EUHN94C	Var Prop PKHU94C	Var Prop PKHN94C	Var Prop EUHU94L	Var Prop EUHN94L	Var Prop PKHU94L	Var Prop PKHN94L	Var Prop CDD	Var Prop HDD60
1	0.0059	0.0105	0.0116	0.0078	0.0081	0.0124	0.0117	0.0182	0.0095
2	0.0189	0.0048	0.0224	0.0471	0.0215	0.0001	0.0159	0.0032	0.0031

Number	Var Prop EUHN94C	Var Prop PKHU94C	Var Prop PKHN94C	Var Prop EUHU94L	Var Prop EUHN94L	Var Prop PKHU94L	Var Prop PKHN94L	Var Prop CDD	Var Prop HDD60
3	0.0719	0.0083	0.0008	0.0185	0.0683	0.0002	0.0031	0.0038	0.0015
4	0.0086	0.0882	0.0011	0.0031	0.0027	0.0268	0.0229	0.0190	0.0440
5	0.0023	0.0067	0.0826	0.0046	0.0003	0.0350	0.0289	0.0107	0.0508
6	0.0229	0.0012	0.0211	0.0132	0.0030	0.0672	0.0279	0.0740	0.0726
7	0.0035	0.0039	0.0023	0.0035	0.0128	0.1550	0.1029	0.0402	0.0964
8	0.0001	0.0004	0.0003	0.0014	0.0007	0.0003	0.0002	0.0000	0.0001
9	0.0018	0.0140	0.0031	0.0085	0.0008	0.0620	0.0009	0.0030	0.0682
10	0.0022	0.0250	0.0162	0.0043	0.0078	0.0352	0.0460	0.0042	0.0199
11	0.0756	0.0008	0.1746	0.0836	0.0585	0.0329	0.1777	0.0240	0.0264
12	0.3833	0.0370	0.0415	0.0057	0.3495	0.0936	0.0375	0.0074	0.0576
13	0.0455	0.0734	0.0094	0.0005	0.0023	0.3056	0.0490	0.1244	0.0179
14	0.0326	0.0226	0.0615	0.2525	0.0414	0.0406	0.0634	0.0249	0.0787
15	0.0004	0.0089	0.0004	0.0096	0.0359	0.0034	0.1098	0.2518	0.4405
16	0.2453	0.0561	0.0085	0.0032	0.3570	0.0199	0.0365	0.0000	0.0070
17	0.0585	0.5436	0.0934	0.0000	0.0100	0.0447	0.0021	0.3331	0.0045
18	0.0175	0.0042	0.0323	0.4980	0.0172	0.0003	0.0379	0.0000	0.0011
19	0.0032	0.0906	0.4169	0.0348	0.0021	0.0648	0.2256	0.0578	0.0001

Number	Var Prop ETOT	Var Prop AGGSIC3	Var Prop SCHGHRS	Var Prop SCHGSQF
1	0.0184	0.0163	0.0003	0.0015
2	0.0067	0.0027	0.0001	0.0010
3	0.0032	0.0017	0.0004	0.0049
4	0.0316	0.0215	0.0058	0.0132
5	0.0087	0.0474	0.0100	0.0426
6	0.0049	0.0418	0.0364	0.1025

```
     7    0.0954    0.0005    0.0296    0.1438
     8    0.0000    0.0018    0.7928    0.1783
     9    0.0009    0.1049    0.1025    0.4472
    10    0.0415    0.4555    0.0098    0.0042
    11    0.0114    0.0459    0.0026    0.0064
    12    0.0198    0.0272    0.0001    0.0003
    13    0.2825    0.1538    0.0079    0.0385
    14    0.0654    0.0046    0.0003    0.0130
    15    0.2075    0.0554    0.0006    0.0007
    16    0.0227    0.0014    0.0007    0.0011
    17    0.1260    0.0077    0.0000    0.0001
    18    0.0008    0.0014    0.0002    0.0005
    19    0.0526    0.0087    0.0001    0.0000
```

Table 3A: Autocorrelation Diagnostics

```
Univariate Procedure

Variable=AUTOCORR

                 Moments                                Quantiles(Def=5)

 N               376  Sum Wgts        376   100% Max  0.966381       99%  0.957525
 Mean       0.779998  Sum        293.2794    75% Q3   0.868509       95%  0.932588
 Std Dev    0.161751  Variance   0.026163    50% Med  0.827304       90%  0.910648
 Skewness   -2.41489  Kurtosis   7.807781    25% Q1   0.756227       10%   0.57184
 USS        238.5688  CSS         9.81127     0% Min  -0.29134        5%  0.430083
 CV         20.73735  Std Mean   0.008342                             1%  0.163456
 T:Mean=0   93.50626  Pr>|T|       0.0001   Range     1.257725
 Num ^= 0        376  Num > 0         375   Q3-Q1     0.112282
 M(Sign)         187  Pr>=|M|      0.0001   Mode      -0.29134
 Sgn Rank      35428  Pr>=|S|      0.0001


                 Extremes

    Lowest    Obs     Highest    Obs
  -0.29134(     245) 0.955142(     158)
  0.148929(      57) 0.957525(     296)
  0.152745(     116) 0.957612(     254)
  0.163456(      11) 0.961904(     345)
  0.170009(     102) 0.966381(     346)
```

Table 3B: Autocorrelation Diagnostics

```
Univariate Procedure

Variable=DW

                 Moments                                Quantiles(Def=5)

 N               376  Sum Wgts        376   100% Max  4.975135       99%  1.523178
 Mean       0.434015  Sum        163.1896    75% Q3   0.481981       95%   1.05414
 Std Dev    0.375939  Variance    0.14133    50% Med  0.356774       90%  0.778258
 Skewness   5.802531  Kurtosis   59.14646    25% Q1   0.237536       10%  0.158052
 USS        123.8255  CSS        52.99879     0% Min  0.055259        5%  0.113242
 CV         86.61893  Std Mean   0.019388                             1%  0.062016
 T:Mean=0   22.38624  Pr>|T|       0.0001   Range     4.919876
 Num ^= 0        376  Num > 0         376   Q3-Q1     0.244446
 M(Sign)         188  Pr>=|M|      0.0001   Mode      0.055259
 Sgn Rank      35438  Pr>=|S|      0.0001


                 Extremes

    Lowest    Obs     Highest    Obs
  0.055259(     362) 1.503999(      43)
  0.056345(     348) 1.523178(      11)
  0.060788(     158) 1.661601(     116)
  0.062016(     292)  2.55854(     245)
  0.067522(     345) 4.975135(     336)
```

```
TABLE 4 --- HETEROSCEDASTICITY
HETEROSCEDASTICITY AND SPECIFICATION ERROR                       05:05 Thursday, March 14, 1996 241
========================================
----- CORRELATIONAL CHECK FOR HETEROSCEDASTICITY -----


Pearson Correlation Coefficients  / N = 16742  / WEIGHT Var = WSTOR
```

```
                                               ABSR1

EUHU94D                                      0.11308
dummy, sbw sample hvac energy usg
EUHN94D                                      0.04768
dummy, sbw sample hvac non energy
PKHU94D                                      0.00129
dummy, PGE        hvac energy usg
PKHN94D                                     -0.01044
dummy, PGE        hvac non energy
EUHU94C                                      0.08393
product, SBW hvac hu*cooling degrees
EUHN94C                                      0.02823
product, SBW hvac hn*cooling degrees
PKHU94C                                      0.00470
product, PGE hvac hu*cooling degrees
PKHN94C                                     -0.00742
product, PGE hvac hn*cooling degrees
EUHU94L                                      0.11962
dummy product, SBW hvac hu*lighting
EUHN94L                                      0.02872
dummy product, SBW hvac hn*lighting
PKHU94L                                      0.06847
dummy product, PGE hvac hu*lighting
PKHN94L                                      0.02664
dummy product, PGE hvac hn*lighting
CDD                                          0.03918
cdd at this btype setpoint
HDD60                                        0.00470
heating degree days, base 60
ETOT                                         0.01947
tot emp for mo, territory
AGGSIC3                                      0.22546
agg sic3, territory
SCHGHRS                                     -0.10527
chghrs* meanpre
SCHGSQF                                      0.20722
chgsqf* meanpre
EUHU94N                                      0.08409
product, SBW hvac hu *long run cdd
EUHN94N                                      0.02944
product, SBW hvac hn *long run cdd
PKHU94N                                      0.00360
product, PGE hvac hu *long run cdd
PKHN94N                                     -0.00804
product, PGE hvac hn *long run cdd


TABLE #5 PECIFICATION BIAS EXAMINATION VIA RESIDUAL CHECKS              05:05 Thursday, March 14, 1996
=================================================
----- CORRELATIONAL CHECK --------

Correlation Analysis

                                                     Simple Statistics

Pearson Correlation Coefficients  / Number of Observations  / WEIGHT Var = WSTOR

                                                   RESID1

AGGSIC4                                           0.00138
agg sic2 x cz kwh                                   16742

AGGSIC4N                                          0.00981
agg sic2 x cz, norm on mean                         16742

AGGSIC2                                           0.00099
agg sic2, territory                                 16742

EHN94T                                           -0.13782
eval sae - hvac hn, 1994, mo. avg                   16742

EHN94S                                           -0.13791
eval sae - hvac hn, 1994, monthly                   16742

EHN94U                                           -0.13736
eval sae - hvac hn, 1994, mo/denor                  16742

EHN94V                                           -0.13777
eval sae - hvac hn, 1994, mo. avg./denor            16742

EHU94T                                           -0.02667
eval sae - hvac hu, 1994, mo. avg                   16742

EHU94S                                           -0.00483
```

```
eval sae - hvac hu, 1994, monthly                    16742

EHU94U                                             -0.00201
eval sae - hvac hu, 1994, mo/denor                   16742

EHU94V                                             -0.02539
eval sae - hvac hu, 1994, mo. avg./denor             16742

EUHN94T                                            -0.13782
eval up sae - hvac hn, 1994, mo. avg                 16742

EUHN94S                                            -0.13791
eval up sae - hvac hn, 1994, monthly                 16742

EUHN94U                                            -0.13736
eval up sae - hvac hn, 1994, mo/denor                16742

EUHN94V                                            -0.13777
eval up sae - hvac hn, 1994, mo. avg./de             16742

EUHU94T                                            -0.02667
eval up sae - hvac hu, 1994, mo. avg                 16742

EUHU94V                                            -0.02539
eval up sae - hvac hu, 1994, mo. avg./de             16742

PKHN94T                                            -0.01386
pkwh only, hvac hn, 1994, mo. avg                    16742


SPECIFICATION BIAS EXAMINATION VIA RESIDUAL CHECKS                  05:05 Thursday, March 14, 1996 249
=================================================
----- CORRELATIONAL CHECK --------

Correlation Analysis

Pearson Correlation Coefficients  / Number of Observations  / WEIGHT Var = WSTOR

                                                     RESID1

PKHN94S                                            -0.21362
pkwh only, hvac hn, 1994, monthly                    16742

PKHN94U                                            -0.01337
pkwh only, hvac hn, 1994, mo/denor                   16742

PKHN94V                                            -0.01405
pkwh only, hvac hn, 1994, mo. avg./denor             16742

PKHU94T                                            -0.17348
pkwh only, hvac hu, 1994, mo. avg                    16742

PKHU94S                                            -0.25745
pkwh only, hvac hu, 1994, monthly                    16742

PKHU94U                                            -0.13612
pkwh only, hvac hu, 1994, mo/denor                   16742

PKHU94V                                            -0.16844
pkwh only, hvac hu, 1994, mo. avg./denor             16742

PKOT94T                                             0.00515
pkwh only, othet, 1994, mo. avg                      16742

PKOT94S                                             0.00538
pkwh only, othet, 1994, monthly                      16742

PKOT94U                                             0.00538
pkwh only, othet, 1994, mo/denor                     16742

PKOT94V                                             0.00515
pkwh only, othet, 1994, mo. avg./denor               16742

EH94T                                              -0.13103
eval sae - hvac all, 1994, mo. avg                   16742

EH94S                                              -0.11892
eval sae - hvac all, 1994, monthly                   16742

EH94U                                              -0.11659
eval sae - hvac all, 1994, mo/denor                  16742

EH94V                                              -0.13019
eval sae - hvac all, 1994, mo. avg./deno             16742
```

```
SPECIFICATION BIAS EXAMINATION VIA RESIDUAL CHECKS                 05:05 Thursday, March 14, 1996 250
=================================================
----- CORRELATIONAL CHECK --------

Correlation Analysis

Pearson Correlation Coefficients  / Number of Observations  / WEIGHT Var = WSTOR

                                                     RESID1

EUH94T                                             -0.13103
eval up sae - hvac all, 1994, mo. avg                 16742

EUH94S                                             -0.24732
eval up sae - hvac all, 1994, monthly                 16742

EUH94U                                             -0.11659
eval up sae - hvac all, 1994, mo/denor                16742

EUH94V                                             -0.13019
eval up sae - hvac all, 1994, mo. avg./d              16742

PKH94T                                             -0.08216
pkwh only, hvac all, 1994, mo. avg                    16742

PKH94S                                             -0.20846
pkwh only, hvac all, 1994, monthly                    16742

PKH94U                                             -0.08188
pkwh only, hvac all, 1994, mo/denor                   16742

PKH94V                                             -0.08869
pkwh only, hvac all, 1994, mo. avg./deno              16742

PKL94T                                             -0.03746
pkwh only, lits all, 1994, mo. avg                    16742

PKL94S                                             -0.18136
pkwh only, lits all, 1994, monthly                    16742

PKL94U                                             -0.04173
pkwh only, lits all, 1994, mo/denor                   16742

PKL94V                                             -0.03746
pkwh only, lits all, 1994, mo. avg./deno              16742

TRH94T                                             -0.13450
any trkg, hvac all, 1994, mo. avg                     16742

TRH94S                                             -0.12024
any trkg, hvac all, 1994, monthly                     16742

TRH94U                                             -0.11890
any trkg, hvac all, 1994, mo/denor                    16742

SPECIFICATION BIAS EXAMINATION VIA RESIDUAL CHECKS               05:05 Thursday, March 14, 1996 251
=================================================
----- CORRELATIONAL CHECK --------

Correlation Analysis

Pearson Correlation Coefficients  / Number of Observations  / WEIGHT Var = WSTOR

                                                     RESID1

TRH94V                                             -0.13408
any trkg, hvac all, 1994, mo. avg./denor              16742

TRL94T                                             -0.03746
any trkg, lits all, 1994, mo. avg                     16742

FLAGEV                                              0.01668
KWH EV/KWHEV20 suspect                                16742

MEANPRE                                             0.00148
mean pre kwhmo                                        16742

SRCOOL                                             -0.00215
s.r.  rep coolequip*meanpre                           16742

SRCOOLE                                               .
s.r.  effic cool equp * meanpre                       16742

SFIXREP                                            -0.02691
s.r.  fixture rep * meanpre                           16742
```

```
SLAMPRP                                            -0.00009
s.r.  lamp rep * meanpre                              16742

SACOOL                                              0.01039
s.r.  add coolequip*meanpre                           16742

SACOOLE                                             0.00537
s.r.  add effcoolequp*meanpre                         16742

SADDASD                                            -0.01159
s.r.  add asd * meanpre                               16742

SADTIM                                             -0.05536
s.r.  add time clock * meanpre                        16742

SADDHTG                                             0.00052
s.r.  add heatg equip* meanpre                        16742

SPECIFICATION BIAS EXAMINATION VIA RESIDUAL CHECKS               05:05 Thursday, March 14, 1996 252
=================================================
----- CORRELATIONAL CHECK --------

Correlation Analysis

Pearson Correlation Coefficients  / Number of Observations  / WEIGHT Var = WSTOR

                                                     RESID1

SREMLI                                             -0.01441
s.r.  remove lights  * meanpre                        16742

SADDSET                                                .
s.r.  add setback therm * meanpre                     16742

RWT3A                                              -0.00888
part 3a rel wt                                        16742

PROKWH2                                             0.10890
prokwh under aggreg status 2                          16742

POST1                                               0.00903
flags first hvac measure install                      16742

CDDHI                                               0.00241
cdd/mo gt 245                                         16742

CDDHEU                                              0.00361
cdd > 245 * SBW hvac prior                            16742

CDDHPK                                              0.02155
cdd > 245 * PGE hvac prior                            16742

EUHN94X                                            -0.01225
product, SBW hvac hn* lighting prior                  16742

EUHU94X                                            -0.04122
product, SBW hvac hu * lighting prior                 16742

PKHN94X                                            -0.07578
product, PGE hvac hn* lighting prior                  16742

PKHU94X                                            -0.09870
product, PGE hvac hu * lighting prior                 16742

EUH94X                                             -0.04553
product, SBW hvac*lighting prior                      16742

PKH94X                                             -0.06562
product, PGE hvac*lighting prior                      16742

SPECIFICATION BIAS EXAMINATION VIA RESIDUAL CHECKS                        05:05 Thursday, March 14, 1996 254
=================================================
----- CORRELATIONAL CHECK --------

Correlation Analysis

Pearson Correlation Coefficients  / Number of Observations  / WEIGHT Var = WSTOR

                                                     RESID1


EUHN94N                                            -0.00450
product, SBW hvac hn *long run cdd                    16742
```

EUHU94N	-0.00121
product, SBW hvac hu *long run cdd	16742
PKHN94N	0.00134
product, PGE hvac hn *long run cdd	16742
PKHU94N	0.00090
product, PGE hvac hu *long run cdd	16742
TRL94N	0.02602
	16742
EUH94N	-0.00143
product, SBW hvac *long run cdd	16742
PKH94N	-0.00199
product, PGE hvac *long run cdd	16742
DFFITS1	-0.11615
Standard Influence on Predicted Value	16742

TABLE 6- DEADBANDED I26 RERUN (I26D)

Model: MAIN
NOTE: No intercept in model. R-square is redefined.
Dependent Variable: PROKWH2 prokwh under aggreg status 2

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	19	2.6620501E15	1.401079E14	69347.096	0.0001
Error	15595	3.150792E13	2020386008.2		
U Total	15614	2.6935581E15			

Root MSE	44948.70419	R-square	0.9883
Dep Mean	77887.32449	Adj R-sq	0.9883
C.V.	57.70991		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
GLM_MEAN	1	1.000597	0.00093831	1066.379	0.0001
EUHU94D	1	-15505	2961.3009631	-5.236	0.0001
EUHN94D	1	-11123	2586.2431727	-4.301	0.0001
PKHU94D	1	-1602.251137	1436.1410936	-1.116	0.2646
PKHN94D	1	-91.237733	1170.1511178	-0.078	0.9379
EUHU94C	1	85.805958	11.75623398	7.299	0.0001
EUHN94C	1	25.780175	14.38346912	1.792	0.0731
PKHU94C	1	2.210829	6.45490998	0.343	0.7320
PKHN94C	1	-3.934204	6.37549753	-0.617	0.5372
EUHU94L	1	-330.555228	4003.1435068	-0.083	0.9342
EUHN94L	1	37.317030	4153.7352487	0.009	0.9928
PKHU94L	1	-7363.574909	2890.2604421	-2.548	0.0109
PKHN94L	1	-1646.206899	1774.9179082	-0.927	0.3537
CDD	1	21.581739	2.61463457	8.254	0.0001
HDD60	1	-16.399788	2.37898425	-6.894	0.0001
ETOT	1	2.281675	1.47121531	1.551	0.1210
AGGSIC3	1	0.002484	0.00120723	2.057	0.0397
SCHGHRS	1	-0.000200	0.00015657	-1.276	0.2020
SCHGSQF	1	-2.658566E-8	0.00000003	-0.955	0.3396

SEP05-MODEL I2

Model: MAIN
NOTE: No intercept in model. R-square is redefined.
Dependent Variable: PROKWH2 prokwh under aggreg status 2

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	16	5.8757872E15	3.672367E14	71563.928	0.0001
Error	16726	8.5830966E13	5131589491.4		
U Total	16742	5.9616181E15			

Root MSE	71635.11354	R-square	0.9856

Dep Mean	94615.35169	Adj R-sq	0.9856
C.V.	75.71193		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
GLM_MEAN	1	1.003994	0.00106715	940.816	0.0001
EUHU94V	1	-0.279246	0.06032529	-4.629	0.0001
EUHN94V	1	-0.437092	0.03726660	-11.729	0.0001
PKHU94D	1	-2039.473823	1848.3312215	-1.103	0.2699
PKHN94D	1	-2036.036864	1549.7610193	-1.314	0.1889
TRL94T	1	-1.985626	0.20487114	-9.692	0.0001
EUHU94L	1	-18443	5003.5057926	-3.686	0.0002
EUHN94L	1	21543	5601.5337444	3.846	0.0001
PKHU94L	1	-21950	4494.3884931	-4.884	0.0001
PKHN94L	1	-2560.858326	2753.6012147	-0.930	0.3524
CDD	1	25.476115	3.44024304	7.405	0.0001
HDD60	1	-17.806294	3.58810971	-4.963	0.0001
ETOT	1	3.083286	2.21029250	1.395	0.1630
AGGSIC3	1	0.007414	0.00185112	4.005	0.0001
SCHGHRS	1	-0.000187	0.00015926	-1.176	0.2398
SCHGSQF	1	-2.02556E-8	0.00000003	-0.649	0.5165

MODEL A2

Model: MAIN
NOTE: No intercept in model. R-square is redefined.
Dependent Variable: PROKWH2   prokwh under aggreg status 2

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	12	5.8755138E15	4.8962615E14	95133.927	0.0001
Error	16730	8.6104356E13	5146703868.2		
U Total	16742	5.9616181E15			

Root MSE	71740.53156	R-square	0.9856
Dep Mean	94615.35169	Adj R-sq	0.9855
C.V.	75.82335		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
GLM_MEAN	1	1.003263	0.00106332	943.522	0.0001
EUHU94V	1	-0.290740	0.06035207	-4.817	0.0001
EUHN94V	1	-0.423528	0.03721343	-11.381	0.0001
PKHU94D	1	-5480.008656	1697.7109262	-3.228	0.0012
PKHN94D	1	-2627.357003	1345.7562633	-1.952	0.0509
TRL94T	1	-2.200356	0.18120371	-12.143	0.0001
CDD	1	25.691090	3.43552842	7.478	0.0001
HDD60	1	-17.919441	3.58919868	-4.993	0.0001
ETOT	1	3.861789	2.20478476	1.752	0.0799
AGGSIC3	1	0.006583	0.00184812	3.562	0.0004
SCHGHRS	1	-0.000208	0.00015942	-1.302	0.1929
SCHGSQF	1	-2.213091E-8	0.00000003	-0.710	0.4779

APPENDIX F

Billing Regression NTG Model Specifications and Diagnostics

Appendix F

Billing Regression NTG Model Specifications and Diagnostics

The purpose of this appendix is to provide further documentation of the analysis which led to the selection of a billing regression model to use in estimating net program savings and a program net-to-gross ratio. This appendix is presented in two parts. The first part provides descriptive statistics for the variables that were used in various model specifications. The second part provides model specifications and diagnostics for a series of models which were tested.

F.1 Descriptive Statistics for Model Variables

The SAS System 1
13:34 Sunday, March 3, 1996

OFFICE	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Misc	Non-Partic	30	3.4	30	3.4
Misc	Participant	35	4.0	65	7.4
No	Non-Partic	292	33.2	357	40.6
No	Participant	245	27.8	602	68.4
Yes	Non-Partic	120	13.6	722	82.0
Yes	Participant	158	18.0	880	100.0

REST	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Misc	Non-Partic	30	3.4	30	3.4
Misc	Participant	35	4.0	65	7.4
No	Non-Partic	348	39.5	413	46.9
No	Participant	381	43.3	794	90.2
Yes	Non-Partic	64	7.3	858	97.5
Yes	Participant	22	2.5	880	100.0

RETAIL	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Misc	Non-Partic	30	3.4	30	3.4
Misc	Participant	35	4.0	65	7.4
No	Non-Partic	347	39.4	412	46.8
No	Participant	362	41.1	774	88.0
Yes	Non-Partic	65	7.4	839	95.3
Yes	Participant	41	4.7	880	100.0

FOOD	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Misc	Non-Partic	30	3.4	30	3.4
Misc	Participant	35	4.0	65	7.4
No	Non-Partic	378	43.0	443	50.3
No	Participant	394	44.8	837	95.1
Yes	Non-Partic	34	3.9	871	99.0
Yes	Participant	9	1.0	880	100.0

WARE	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Misc	Non-Partic	30	3.4	30	3.4
Misc	Participant	35	4.0	65	7.4
No	Non-Partic	393	44.7	458	52.0
No	Participant	381	43.3	839	95.3
Yes	Non-Partic	19	2.2	858	97.5
Yes	Participant	22	2.5	880	100.0

SCHOOL	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Misc	Non-Partic	30	3.4	30	3.4
Misc	Participant	35	4.0	65	7.4
No	Non-Partic	394	44.8	459	52.2
No	Participant	351	39.9	810	92.0
Yes	Non-Partic	18	2.0	828	94.1
Yes	Participant	52	5.9	880	100.0

CLINIC	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Misc	Non-Partic	30	3.4	30	3.4
Misc	Participant	35	4.0	65	7.4
No	Non-Partic	393	44.7	458	52.0
No	Participant	380	43.2	838	95.2
Yes	Non-Partic	19	2.2	857	97.4
Yes	Participant	23	2.6	880	100.0

HOTLMOTL	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Misc	Non-Partic	30	3.4	30	3.4
Misc	Participant	35	4.0	65	7.4
No	Non-Partic	402	45.7	467	53.1
No	Participant	385	43.8	852	96.8
Yes	Non-Partic	10	1.1	862	98.0
Yes	Participant	18	2.0	880	100.0

PERSREP	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Misc	Non-Partic	30	3.4	30	3.4
Misc	Participant	35	4.0	65	7.4
No	Non-Partic	390	44.3	455	51.7
No	Participant	395	44.9	850	96.6
Yes	Non-Partic	22	2.5	872	99.1
Yes	Participant	8	0.9	880	100.0

COMSERV	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Misc	Non-Partic	30	3.4	30	3.4
Misc	Participant	35	4.0	65	7.4
No	Non-Partic	371	42.2	436	49.5
No	Participant	353	40.1	789	89.7
Yes	Non-Partic	41	4.7	830	94.3
Yes	Participant	50	5.7	880	100.0

OFFICED	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
No	Non-Partic	322	36.6	322	36.6
No	Participant	280	31.8	602	68.4
Yes	Non-Partic	120	13.6	722	82.0
Yes	Participant	158	18.0	880	100.0

RESTD	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
No	Non-Partic	378	43.0	378	43.0
No	Participant	416	47.3	794	90.2
Yes	Non-Partic	64	7.3	858	97.5
Yes	Participant	22	2.5	880	100.0

RETAILD	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
No	Non-Partic	377	42.8	377	42.8
No	Participant	397	45.1	774	88.0
Yes	Non-Partic	65	7.4	839	95.3
Yes	Participant	41	4.7	880	100.0

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FOODD	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
No	Non-Partic	408	46.4	408	46.4
No	Participant	429	48.8	837	95.1
Yes	Non-Partic	34	3.9	871	99.0
Yes	Participant	9	1.0	880	100.0

WARED	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
No	Non-Partic	423	48.1	423	48.1
No	Participant	416	47.3	839	95.3
Yes	Non-Partic	19	2.2	858	97.5
Yes	Participant	22	2.5	880	100.0

SCHOOLD	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
No	Non-Partic	424	48.2	424	48.2
No	Participant	386	43.9	810	92.0
Yes	Non-Partic	18	2.0	828	94.1
Yes	Participant	52	5.9	880	100.0

CLINICD	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
No	Non-Partic	423	48.1	423	48.1
No	Participant	415	47.2	838	95.2
Yes	Non-Partic	19	2.2	857	97.4
Yes	Participant	23	2.6	880	100.0

HOTMOTD	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
No	Non-Partic	432	49.1	432	49.1
No	Participant	420	47.7	852	96.8
Yes	Non-Partic	10	1.1	862	98.0
Yes	Participant	18	2.0	880	100.0

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PERSREPD	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
No	Non-Partic	420	47.7	420	47.7
No	Participant	430	48.9	850	96.6
Yes	Non-Partic	22	2.5	872	99.1
Yes	Participant	8	0.9	880	100.0

COMSERVD	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
No	Non-Partic	401	45.6	401	45.6
No	Participant	388	44.1	789	89.7
Yes	Non-Partic	41	4.7	830	94.3
Yes	Participant	50	5.7	880	100.0

MISCD	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
No	Non-Partic	412	46.8	412	46.8
No	Participant	403	45.8	815	92.6
Yes	Non-Partic	30	3.4	845	96.0
Yes	Participant	35	4.0	880	100.0

BTYPE	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Office_L	Non-Partic	5	0.6	5	0.6
Office_L	Participant	10	1.1	15	1.7
Office_S	Non-Partic	115	13.1	130	14.8
Office_S	Participant	148	16.8	278	31.6
Restaur	Non-Partic	64	7.3	342	38.9
Restaur	Participant	22	2.5	364	41.4
Retail_L	Participant	1	0.1	365	41.5
Retail_S	Non-Partic	65	7.4	430	48.9
Retail_S	Participant	40	4.5	470	53.4
Food	Non-Partic	34	3.9	504	57.3
Food	Participant	9	1.0	513	58.3
Ref-War	Non-Partic	2	0.2	515	58.5
Nref_War	Non-Partic	17	1.9	532	60.5
Nref_War	Participant	22	2.5	554	63.0
El-Sec	Non-Partic	18	2.0	572	65.0
El-Sec	Participant	52	5.9	624	70.9
College	Non-Partic	1	0.1	625	71.0
College	Participant	12	1.4	637	72.4
Hosp	Non-Partic	2	0.2	639	72.6
Hosp	Participant	2	0.2	641	72.8
Clinic	Non-Partic	19	2.2	660	75.0
Clinic	Participant	23	2.6	683	77.6

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BTYPE	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Hotl_motl	Non-Partic	10	1.1	693	78.7
Hotl_motl	Participant	18	2.0	711	80.8
Misc	Non-Partic	27	3.1	738	83.9
Misc	Participant	21	2.4	759	86.3
Pers-rep	Non-Partic	22	2.5	781	88.8
Pers-rep	Participant	8	0.9	789	89.7
Comserv	Non-Partic	41	4.7	830	94.3
Comserv	Participant	50	5.7	880	100.0

OWNBUY	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
No	Non-Partic	235	26.7	235	26.7
No	Participant	162	18.4	397	45.1
Yes	Non-Partic	207	23.5	604	68.6
Yes	Participant	276	31.4	880	100.0

RENT	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
No	Non-Partic	244	27.7	244	27.7
No	Participant	317	36.0	561	63.8
Yes	Non-Partic	198	22.5	759	86.3
Yes	Participant	121	13.8	880	100.0

ADCOOLIN	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent

No	Non-Partic	442	50.2	442	50.2
No	Participant	418	47.5	860	97.7
Yes	Participant	20	2.3	880	100.0

LESHRS	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
No	Non-Partic	422	48.0	422	48.0
No	Participant	428	48.6	850	96.6
Yes	Non-Partic	20	2.3	870	98.9
Yes	Participant	10	1.1	880	100.0

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MORHRS	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
No	Non-Partic	415	47.2	415	47.2
No	Participant	415	47.2	830	94.3
Yes	Non-Partic	27	3.1	857	97.4
Yes	Participant	23	2.6	880	100.0

OWN	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Own/buy	Non-Partic	207	23.5	207	23.5
Own/buy	Participant	276	31.4	483	54.9
Lease/rent	Non-Partic	198	22.5	681	77.4
Lease/rent	Participant	121	13.8	802	91.1
Mang only	Non-Partic	31	3.5	833	94.7
Mang only	Participant	41	4.7	874	99.3
Other	Non-Partic	6	0.7	880	100.0

BLDGOCC	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Prt Bldg	Non-Partic	10	1.2	10	1.2
Prt Bldg	Participant	7	0.9	17	2.1
Entr Bldg	Non-Partic	112	13.8	129	15.9
Entr Bldg	Participant	62	7.6	191	23.5
>1 entre bldg	Non-Partic	183	22.5	374	46.1
>1 entre bldg	Participant	171	21.1	545	67.1
Prt mult bldg	Non-Partic	45	5.5	590	72.7
Prt mult bldg	Participant	96	11.8	686	84.5
DK	Non-Partic	78	9.6	764	94.1
DK	Participant	48	5.9	812	100.0

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RESPPAYS	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
No	Non-Partic	36	4.1	36	4.1
No	Participant	32	3.6	68	7.7
Yes	Non-Partic	406	46.1	474	53.9
Yes	Participant	406	46.1	880	100.0

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SEPMET2	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
No	Non-Partic	96	10.9	96	10.9
No	Participant	94	10.7	190	21.6
Yes	Non-Partic	346	39.3	536	60.9
Yes	Participant	344	39.1	880	100.0

BLTBEFOR	PART2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	Non-Partic	46	5.2	46	5.2

0	Participant	34	3.9	80	9.1
1979	Non-Partic	240	27.3	320	36.4
1979	Participant	305	34.7	625	71.0
1984	Non-Partic	46	5.2	671	76.3
1984	Participant	33	3.8	704	80.0
1989	Non-Partic	58	6.6	762	86.6
1989	Participant	40	4.5	802	91.1
1996	Non-Partic	52	5.9	854	97.0
1996	Participant	26	3.0	880	100.0

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Variable	Label	N	Mean	Std Dev	Minimum	Maximum
PREMID2	Premise ID	442	3584603.51	2134459.28	1734.00	6080356.00
PER1SR	First SR 94 HVAC change	442	30.0316742	0.9613348	25.0000000	36.0000000
PER1SRHN	First SR 94 hvac-nonu chg	442	96.8212670	12.0705485	25.0000000	99.0000000
PER1SRHU	First SR 94 hvac-using chg	442	94.1742081	17.6120698	25.0000000	99.0000000
PER1	First measure for part94	63	99.0000000	0	99.0000000	99.0000000
PER1HN	First hvac nonus period part94	63	99.0000000	0	99.0000000	99.0000000
PER1HU	First hvac using period part94	63	99.0000000	0	99.0000000	99.0000000
NWT2	Expansion weight	442	517.8031674	647.9885927	66.8591549	2130.35
RWT2	Relative weight	442	1.0000000	1.2514188	0.1291208	4.1141993
PIVOT	Month seq of first install	442	30.0316742	0.9613348	25.0000000	36.0000000
PREKWH1	Month 1 kwh-pre	442	47455.19	159884.89	83.3121212	1798830.00
PREKWH2		442	49642.50	164992.46	86.1000000	1862057.09
PREKWH3		442	49883.61	165355.99	113.8642241	1835061.29
PREKWH4		442	46819.23	153391.60	133.8580645	1809448.16
PREKWH5		442	46906.17	162314.27	147.0990783	1860374.41
PREKWH6		442	43238.79	151567.56	118.8610547	1741009.03
PREKWH7		442	42555.40	147688.41	158.1250000	1757129.09
PREKWH8		442	43153.91	148207.07	157.1250000	1723432.29
PREKWH9		442	39510.59	135622.80	130.6666666	1621398.62
PREKWH10		442	44204.67	153230.62	144.7000000	1867404.82
PREKWH11		440	43271.04	146060.99	133.3620690	1752048.72
PREKWH12	Month 12 kwh-pre	438	45125.42	150024.34	127.9045977	1801968.52
PSTKWH1	Month 1 kwh-pst	442	45786.97	145151.33	119.0145833	1752876.64
PSTKWH2		442	48406.43	152763.27	124.2187500	1828345.16
PSTKWH3		442	48943.11	154485.37	131.3939394	1851866.13
PSTKWH4		442	46462.22	150104.67	135.3203463	1804463.79
PSTKWH5		442	45597.64	152819.12	146.3201970	1847555.17
PSTKWH6		442	41937.54	142043.64	147.2321839	1776743.53
PSTKWH7		442	41845.12	140717.04	156.8242424	1809690.72
PSTKWH8		442	42283.48	142686.24	143.7096774	1792390.52
PSTKWH9		442	39031.02	131132.20	102.0367816	1636809.70
PSTKWH10		442	42925.77	144767.69	79.1546162	1808948.27
PSTKWH11		440	41757.44	139249.55	68.3626251	1738862.07
PSTKWH12	Month 12 kwh-pst	438	43799.07	141656.27	63.8459770	1737373.70
DIFKWHMN	Mean monthly diff in kwh	442	1078.29	15653.59	-26038.41	312769.25
PREAGG1	Agg kwh btype & SIC mo1 pre	441	64922.93	84574.08	1296.41	317413.56
PREAGG2		441	71753.64	93471.65	1636.60	358052.25
PREAGG3		441	71318.95	92667.50	1549.77	356465.11
PREAGG4		441	67221.15	88596.83	1272.89	323177.88
PREAGG5		441	63385.62	85134.71	1002.30	294433.40
PREAGG6		441	54841.22	72593.55	894.5699882	287661.04
PREAGG7		441	52791.36	68248.93	954.1934219	316902.08
PREAGG8		441	54801.17	70398.43	1034.54	312429.46
PREAGG9		441	51646.20	67947.18	940.5894718	287854.05
PREAGG10		441	56791.39	75047.21	981.2383178	286283.28
PREAGG11		441	57660.36	76431.79	987.2553476	286087.93
PREAGG12	Agg kwh btype & SIC mo12 pre	441	62755.43	82878.58	1158.90	317398.34
PSTAGG1		441	66919.08	87776.37	1486.69	345598.41
PSTAGG2		441	73579.26	96130.76	1854.08	399598.72
PSTAGG3		441	73278.09	95878.63	1726.13	393366.55
PSTAGG4		441	67626.86	89124.74	1357.89	345960.92
PSTAGG5		441	61622.21	80952.31	1048.12	299070.09
PSTAGG6		441	54388.60	70454.54	947.4838062	271020.78
PSTAGG7		441	54068.26	69308.93	1041.09	292778.35
PSTAGG8		441	53940.97	69483.72	1028.35	294930.57

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Variable	Label	N	Mean	Std Dev	Minimum	Maximum
PSTAGG9		441	50555.93	65532.03	906.6358535	274232.45
PSTAGG10		441	55952.42	72732.73	999.3458226	289144.63
PSTAGG11		439	55512.47	72682.54	943.1306729	300271.46
PSTAGG12		437	61747.34	81700.14	1072.68	304916.03
DIFAGMN	Pre-pst diff in agg kwh	441	98.5416527	10547.25	-70557.82	72930.17
PRECDD1	Month 1 # cool degree days-pre	442	183.1809955	125.7677332	0	549.0000000

PRECDD2		442	211.7533937	181.1760655	0	691.0000000
PRECDD3		442	223.5339367	160.8216995	0	680.0000000
PRECDD4		442	145.5407240	127.5004581	0	541.0000000
PRECDD5		442	49.3891403	52.1364655	0	315.0000000
PRECDD6		442	4.5226244	23.7134382	0	249.0000000
PRECDD7		442	3.4185520	27.7446883	0	449.0000000
PRECDD8		442	4.8914027	38.6077662	0	626.0000000
PRECDD9		442	5.5701357	43.7088472	0	602.0000000
PRECDD10		442	7.6968326	44.4679144	0	626.0000000
PRECDD11		442	21.4321267	47.4892628	0	602.0000000
PRECDD12	Month 12 # cool deg days-pre	442	58.9366516	79.2869616	0	492.0000000
PSTCDD1	Month 1 # cool degree days-pst	442	155.5746606	153.9796644	0	647.0000000
PSTCDD2		442	214.4276018	226.2929101	0	781.0000000
PSTCDD3		442	227.7420814	197.1433552	0	757.0000000
PSTCDD4		442	135.6357466	120.2054209	0	504.0000000
PSTCDD5		442	25.9411765	30.3295756	0	300.0000000
PSTCDD6		442	2.3891403	17.9025498	0	193.0000000
PSTCDD7		442	2.2013575	20.1444376	0	341.0000000
PSTCDD8		442	4.2511312	34.1528220	0	559.0000000
PSTCDD9		442	5.6538462	40.0482147	0	597.0000000
PSTCDD10		442	5.8755656	42.7180854	0	559.0000000
PSTCDD11		440	13.7431818	41.3275702	0	597.0000000
PSTCDD12	Month 12 # cool deg days-pst	438	47.5730594	64.1923804	0	422.0000000
DIFCDDMN	Mean monthly diff in cdd	442	6.5929419	9.9481939	-24.4166667	37.0833333
PREHDD1	Month 1 heating degree days-pre	442	12.1334842	50.1708447	0	406.0000000
PREHDD2		442	8.9841629	47.5782894	0	527.0000000
PREHDD3		442	7.6719457	49.4577268	0	499.0000000
PREHDD4		442	8.4072398	42.1681844	0	446.0000000
PREHDD5		442	14.9162896	53.6134206	0	415.0000000
PREHDD6		442	173.0158371	72.7479557	0	527.0000000
PREHDD7		442	351.9185520	100.2713899	0	527.0000000
PREHDD8		442	294.4117647	86.4764404	0	499.0000000
PREHDD9		442	246.1990950	75.4757620	0	448.0000000
PREHDD10		442	83.3800905	51.4967834	0	361.0000000
PREHDD11		442	61.4660633	42.4212754	0	317.0000000
PREHDD12	Month 12 heat degree days-pre	442	26.5995475	48.6299395	0	361.0000000
PSTHDD1	Month 1 heat degree days-pst	442	11.7647059	50.7889575	0	490.0000000
PSTHDD2		442	13.4705882	55.8202516	0	547.0000000
PSTHDD3		442	7.6357466	47.8230951	0	520.0000000
PSTHDD4		442	7.3325792	37.5532913	0	317.0000000
PSTHDD5		442	27.2398190	69.1703110	0	490.0000000
PSTHDD6		442	301.0203620	75.6425659	0	547.0000000
PSTHDD7		442	380.4570136	102.7536923	0	547.0000000
PSTHDD8		442	196.1018100	59.9813731	0	368.0000000
PSTHDD9		442	126.9524887	49.4478814	0	466.0000000
PSTHDD10		442	140.0904977	63.6607074	0	391.0000000
PSTHDD11		440	84.3863636	46.6550448	0	306.0000000
PSTHDD12	Month 12 heat degree days-pst	438	37.5913242	51.6009119	0	391.0000000
DIFHDDMN	Pre-pst monthly diff in hdd	442	-3.8070273	6.9568643	-34.0833333	12.0000000

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Variable	Label	N	Mean	Std Dev	Minimum	Maximum
PRECPI1	Month 1 consumer price index-pre	442	1.8822270	0.0021706	1.8736490	1.8950860
PRECPI2		442	1.8793867	0.0026794	1.8736490	1.9057530
PRECPI3		442	1.8795434	0.0032963	1.8736490	1.9057530
PRECPI4		442	1.8802612	0.0046443	1.8791070	1.9057530
PRECPI5		442	1.8949502	0.0027284	1.8791070	1.9098830
PRECPI6		442	1.8950413	0.0029516	1.8791070	1.9098830
PRECPI7		442	1.8954749	0.0035831	1.8791070	1.9098830
PRECPI8		442	1.9053698	0.0037120	1.8791070	1.9232740
PRECPI9		442	1.9054584	0.0039077	1.8791070	1.9232740
PRECPI10		442	1.9060359	0.0028654	1.8950860	1.9232740
PRECPI11		442	1.9099156	0.0030653	1.8950860	1.9369700
PRECPI12	Month12 consumer price index-pre	442	1.9100685	0.0036190	1.8950860	1.9369700
PSTCPI1	Month 1 consumer price index-pst	442	1.9108135	0.0044344	1.9057530	1.9369700
PSTCPI2		442	1.9231894	0.0035609	1.9057530	1.9515870
PSTCPI3		442	1.9233485	0.0040917	1.9057530	1.9515870
PSTCPI4		442	1.9240709	0.0049386	1.9098830	1.9515870
PSTCPI5		442	1.9367389	0.0044243	1.9098830	1.9642430
PSTCPI6		442	1.9368954	0.0048456	1.9098830	1.9642430
PSTCPI7		442	1.9377779	0.0049475	1.9232740	1.9642430
PSTCPI8		442	1.9512773	0.0043503	1.9232740	1.9735090
PSTCPI9		442	1.9514051	0.0046401	1.9232740	1.9735090
PSTCPI10		442	1.9522060	0.0042877	1.9369700	1.9735090
PSTCPI11		440	1.9638204	0.0037834	1.9369700	1.9735090
PSTCPI12	Month12 consumer price index-pst	438	1.9638396	0.0038201	1.9369700	1.9735090
DIFCPIMN	Pre-pst diff in cpi	442	-0.0443293	0.0013144	-0.0493171	-0.0364412
PRETAX1	Month 1 taxable sales-pre	442	196.4402790	0.2941688	194.9203000	197.9735000
PRETAX2		442	196.6771670	0.4822977	194.9203000	202.6166000
PRETAX3		442	196.7070774	0.6288953	194.9203000	202.6166000
PRETAX4		442	196.8161258	0.8286626	196.4308000	202.6166000
PRETAX5		442	198.0258057	0.6991752	196.4308000	203.6260000
PRETAX6		442	198.0618873	0.8231310	196.4308000	203.6260000
PRETAX7		442	198.2306527	1.1728488	196.6621000	203.6260000
PRETAX8		442	202.5168369	0.9369796	196.6621000	207.6677000
PRETAX9		442	202.5419762	1.0001715	196.6621000	207.6677000

PRETAX10		442	202.6628077	0.9439547	197.9735000	207.6677000
PRETAX11		442	203.6167405	1.0013283	197.9735000	211.2571000
PRETAX12	Month 12 taxable sales-pre	442	203.6604145	1.1413576	197.9735000	211.2571000
PSTTAX1	Month 1 taxable sales-pst	442	203.9012998	1.2761747	202.6166000	211.2571000
PSTTAX2		442	207.6031848	0.8524789	202.6166000	211.2571000
PSTTAX3		442	207.6146369	0.8716323	202.6166000	211.2571000
PSTTAX4		442	207.7459258	0.8925725	203.6260000	211.2571000
PSTTAX5		442	211.0672590	1.0568542	203.6260000	211.7495000
PSTTAX6		442	211.0630319	1.0653045	203.6260000	211.7495000
PSTTAX7		442	211.0913072	0.7241437	207.6677000	211.7495000
PSTTAX8		442	208.4899348	0.6183567	207.6677000	214.2511000
PSTTAX9		442	208.5239620	0.7455017	207.6677000	214.2511000
PSTTAX10		442	208.6900502	1.0570290	208.4039000	214.2511000
PSTTAX11		440	211.7453645	0.4374545	208.4039000	214.2511000
PSTTAX12	Month 12 taxable sales-pst	438	211.7510571	0.4545079	208.4039000	214.2511000
DIFTAXMN	Pre-pst diff in taxable sales	442	-9.4522038	0.1989834	-9.7951750	-7.4766200
PREINC1	Month 1 per capita income-pre	442	17.2986394	4.4508371	11.8992300	26.0876880
PREINC2		442	17.3219862	4.4588234	11.8851800	26.0876880
PREINC3		442	17.3208118	4.4597725	11.8851800	26.0876880
PREINC4		442	17.3240055	4.4624981	11.8851800	26.0912840
PREINC5		442	17.3376636	4.4576919	11.9031500	26.0912840

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Variable	Label	N	Mean	Std Dev	Minimum	Maximum
PREINC6		442	17.3359653	4.4580028	11.9031500	26.0912840
PREINC7		442	17.3314794	4.4618578	11.9031500	26.0912840
PREINC8		442	17.0756109	4.3239805	11.9199800	26.0876880
PREINC9		442	17.0783128	4.3232997	11.9199800	26.0876880
PREINC10		442	17.0859229	4.3197414	11.9199800	26.1071890
PREINC11		442	17.4053023	4.4314256	11.9379400	26.1071890
PREINC12	Month12 per capita income-pre	442	17.4053438	4.4310246	11.9379400	26.1071890
PSTINC1	Month 1 per capita income-pst	442	17.4002896	4.4185619	11.9379400	26.1071890
PSTINC2		442	17.3844491	4.3643629	11.9892500	26.0112950
PSTINC3		442	17.3857549	4.3634349	11.9892500	26.0112950
PSTINC4		442	17.3988662	4.3738648	11.9892500	26.1463860
PSTINC5		442	17.4746516	4.3866577	12.0739100	26.1463860
PSTINC6		442	17.4754460	4.3861434	12.0739100	26.1463860
PSTINC7		442	17.4796018	4.3826560	12.0739100	26.3845780
PSTINC8		442	17.6035985	4.4106077	12.2149400	26.3845780
PSTINC9		442	17.6036570	4.4104382	12.2149400	26.3845780
PSTINC10		442	17.6076167	4.4120920	12.2149400	26.3845780
PSTINC11		440	17.6068939	4.3831630	12.2999900	26.2562570
PSTINC12	Month12 per capita income-pst	438	17.6243366	4.3855577	12.2999900	26.2562570
DIFINCMN	Pre-pst diff in per cap inc	442	-0.2241941	0.1876093	-0.7479392	0.0788485
PREEMP1	Month 1 commer employ-pre	442	230.8631720	211.8815807	18.4665390	600.8760793
PREEMP2		442	231.4876056	212.2607358	18.5544960	600.8760793
PREEMP3		442	231.4896612	212.2647277	18.5544960	600.8760793
PREEMP4		442	231.5107104	212.2494637	18.5544960	601.1497112
PREEMP5		442	232.1373071	212.5445279	18.7494510	601.1497112
PREEMP6		442	232.1421360	212.5479692	18.7494510	601.1497112
PREEMP7		442	232.1691377	212.5289330	18.7494510	601.1497112
PREEMP8		442	232.3248201	211.7481362	19.1083120	600.8760793
PREEMP9		442	232.3274207	211.7513241	19.1083120	600.8760793
PREEMP10		442	232.3564463	211.7523112	19.1083120	601.1497112
PREEMP11		442	232.8137226	212.0015938	19.3070910	601.1497112
PREEMP12	Month 12 commer employ-pre	442	232.8129584	212.0009415	19.3070910	601.1497112
PSTEMP1	Month 1 commer employ-pst	442	232.8009273	211.9477406	19.3070910	600.6610676
PSTEMP2		442	232.4963999	211.2159794	19.4563230	598.5968877
PSTEMP3		442	232.4958374	211.2101635	19.4563230	598.5968877
PSTEMP4		442	232.5356463	211.2410838	19.4563230	600.6610676
PSTEMP5		442	232.6988936	211.0416454	19.5560080	600.6610676
PSTEMP6		442	232.7013158	211.0403550	19.5560080	600.6610676
PSTEMP7		442	232.7060393	211.0208180	19.5560080	605.4354758
PSTEMP8		442	233.8269515	212.3378942	19.5750750	605.4354758
PSTEMP9		442	233.8296359	212.3396382	19.5750750	605.4354758
PSTEMP10		442	233.8489610	212.3504275	19.5750750	606.5523531
PSTEMP11		440	234.5681427	212.8029339	19.6756730	606.5523531
PSTEMP12	Month 12 commer employ-pst	438	235.4094507	212.9240552	19.6756730	606.5523531
DIFEMPMN	Pre-pst diff in employ	442	-1.1254517	1.7024177	-4.8904850	1.9090331
CNTL1	CONTROL NUMBER	442	3334272.56	1998871.61	1734.00	5995172.00
ID1	ID number for interview	442	1959.62	520.7613385	1002.00	2799.00
AUDIT	energy audit	442	1.8144796	0.3891596	1.0000000	2.0000000
BTYPE	Bldg type	442	6.8371041	5.0794753	1.0000000	16.0000000
OWN	own or lease	442	1.6289593	0.6753672	1.0000000	4.0000000
BLDGOCC	Who occupies building	428	2.1612150	1.0798085	0	4.0000000
RESPPAYS	respondent pays for elec	442	0.9185520	0.2738318	0	1.0000000
SEPMET2	separate meter dummy	442	0.7828054	0.4128034	0	1.0000000
BLTBEFOR	bldg built before this year	442	1776.87	606.3164589	0	1996.00
GLASPCT2	glass pct approxim	403	24.7394541	19.2559122	0	100.0000000

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Variable	Label	N	Mean	Std Dev	Minimum	Maximum
COOLSF	calc elec cooled sqft	309	26250.05	62710.71	0	500000.00
HEATSF	calc elec heated sqft	94	18062.45	34959.85	104.0000000	228800.00
WEEKHRS	weekly hrs at survey time	442	78.8800903	43.3784993	0	168.0000000
SUMPEMS	EMS installatns-pre x fract	442	0.0103695	0.0964013	0	1.0000000
SUMPOEMS	EMS installatns-pst x fract	442	0.0054676	0.0677047	0	1.0000000
SUMPHRS	Chgs in hours-pre x frac	442	-0.0246983	3.6728333	-33.3333333	55.0000000
SUMPOHRS	Chgs in hours-pst x frac	442	-0.0248869	4.3056682	-75.0000000	25.0000000
SUMPSQF	Chgs in sqft-pre x fraction	442	26.8604827	316.0849451	-533.3333333	5625.00
SUMPOSQF	Chgs in sqft-pst x fraction	442	34.1251885	560.1409420	0	11250.00
SUMSQF	Chgs in sqft-pre+pst x frac	442	60.9856712	642.0098187	-533.3333333	11250.00
SUMEMS	EMS install-pre+pst x frac	442	0.0158371	0.1173179	0	1.0000000
SUMHRS	Chgs in hours-pre+pst x frac	442	-0.0495852	5.5264010	-75.0000000	55.0000000
SUMPASD	ASD installatns-pre x frac	442	0.0022624	0.0475651	0	1.0000000
SUMPOASD	ASD installatns-pst x frac	442	0	0	0	0
SUMASD	ASD install-pre+pst x frac	442	0.0022624	0.0475651	0	1.0000000
SUMPTIM	Timer install-pre x frac	442	0.0231900	0.1431199	0	1.0000000
SUMPOTIM	Timer install-pst x frac	442	0.0067873	0.0683955	0	0.8333333
SUMTIM	Timer install-pre+pst x frac	442	0.0299774	0.1587204	0	1.0000000
SUMPRC	Cool equip replac-pre x frac	442	0.0601433	0.2287440	0	1.0000000
SUMPORC	Cool equip replac-pst x frac	442	0.0275264	0.1540875	0	1.0000000
SUMRC	Cool equip replacments x frac	442	0.0876697	0.2847151	0	2.0000000
SUMPRCE	Eff cool equip rep-pre x frac	442	0.0022624	0.0475651	0	1.0000000
SUMPORCE	Eff cool equip rep-pst x frac	442	0	0	0	0
SUMRCE	Eff cool equip replac x frac	442	0.0022624	0.0475651	0	1.0000000
SUMPAC	Cool equip added-pre x frac	442	0.0233786	0.1538543	0	1.9166667
SUMPOAC	Cool equip added-pst x frac	442	0.0175339	0.1241900	0	1.0000000
SUMAC	Cool equip added-pre+pst x frac	442	0.0409125	0.1956339	0	1.9166667
SUMPACE	Effic cool equip added x frac	442	0.0022624	0.0475651	0	1.0000000
SUMPOACE	Effic cool equip added x frac	442	0	0	0	0
SUMACE	Effic cool equip added x frac	442	0.0022624	0.0475651	0	1.0000000
SUMPHTG	Heat equip install-pre x frac	442	0.0160256	0.1349588	0	1.9166667
SUMPOHTG	Heat equip install-pst x frac	442	0	0	0	0
SUMHTG	Heat equip install-pre+pstxfrac	442	0.0160256	0.1349588	0	1.9166667
SUMPFRP	Fixture replac-pre x frac	442	0.4153469	1.5312879	0	6.5000000
SUMPOFRP	Fixture replac-pst x fraction	442	0.4189291	1.5219259	0	6.5000000
SUMFRP	Fixture replac-pre+pst x frac	442	0.8342760	3.0437955	0	13.0000000
SUMPLRP	Lamp replac-pre x fraction	442	4.9215686	2.7802893	0	6.5000000
SUMPOLRP	Lamp replac-pst x fraction	442	4.9242081	2.7315668	0	6.5000000
SUMLRP	Lamp replace-pre+pst x fraction	442	9.8457768	5.5023217	0	13.0000000
SUMPRLI	Light removals-pre x fraction	442	0.0011312	0.0202025	0	0.4166667
SUMPORLI	Light removals-pst x fraction	442	0.0030852	0.0429622	0	0.6363636
SUMRLI	Light removals-pre+pst x fracti	442	0.0042164	0.0474014	0	0.6363636
SUMPELO	Else other install-pre x fract	442	0.1532805	0.9689497	0	6.5000000
SUMPOELO	Else other install-pst x frac	442	0.1444193	0.9353512	0	6.5000000
SUMELO	Else oth install-pre+pst x frac	442	0.2976998	1.8985273	0	13.0000000
SUMPOHT	Oth heat install-pre x frac	442	0.0314857	0.4373711	0	6.5000000
SUMPOOHT	Other heat install-pst x frac	442	0.0437406	0.4491009	0	6.5000000
SUMOHT	Oth heat install-pre+pst x frac	442	0.0752262	0.8794569	0	13.0000000
SUMPLN	Light non-usg instl-prexfrac	63	0.0039683	0.0314970	0	0.2500000
SUMPOLN	Light non-usg instl-prexfrac	63	0.0687831	0.3176906	0	1.6666667
SUMLN	Light non-usg instl-pre+pstxfrac	63	0.0727513	0.3183782	0	1.6666667
SUMPLU	Light usg install-pre x frac	63	0.1203704	0.3925202	0	2.0000000
SUMPOLU	Lightusg install-pst x frac	63	0.5291005	1.4042114	0	8.7500000
SUMLU	Light usg install-pre+pst x frac	63	0.6494709	1.4134339	0	8.7500000
SUMPOT	Other install-pre period x frac	63	0.0423280	0.1532745	0	0.8333333

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Variable	Label	N	Mean	Std Dev	Minimum	Maximum
SUMPOOT	Other install-pst periodxfrac	63	0.0396825	0.1631738	0	1.0000000
SUMOT	Other install-pre+pst x fraction	63	0.0820106	0.2424912	0	1.0000000
SUMPHN	HVAC nonusg-pre period x frac	63	0.0171958	0.0794227	0	0.4166667
SUMPOHN	HVAC nonusg-pst period x frac	63	0.0502646	0.1977357	0	0.9166667
SUMHN	HVAC nonusg-pre+pst period xfrac	63	0.0674603	0.2089277	0	0.9166667
SUMPHU	HVAC ener-usg-pre period x frac	63	0	0	0	0
SUMPOHU	HVAC ener-usg-pst period xfrac	63	0.0132275	0.1049901	0	0.8333333
SUMHU	HVAC enerusg-pre+pst periodxfrac	63	0.0132275	0.1049901	0	0.8333333
CDDM	Pre-pst mean diff cool deg days	442	78.2663513	59.1507121	0.1818182	279.2727273
HDDM	Pre-pst mean diff heat deg days	442	114.7731386	23.8318677	68.5454545	212.7272727
CPIM	Pre-pst mean diff cons price ind	442	1.8939695	0.0027603	1.8813872	1.9135260
EMPM	Pre-pst mean diff employment	442	231.9656491	212.1372743	18.8191279	600.7933332
INCM	Pre-pst mean diff taxable income	442	17.2650636	4.4165223	11.9056455	25.9860004
TAXM	Pre-pst mean diff taxable sales	442	199.2997596	0.6944241	196.3624182	204.6328636
PROBPART	Calc prob of parti-from logit	442	1.2800483	7.3342573	0.1530413	153.6101959
P	probpart div by 1 + probpart	442	0.4496449	0.1070031	0.1327284	0.9935321
MILLS	Inverse Mills ratio	442	-1.2746103	0.3907815	-6.0376661	-0.4514624
MILLS2	Inverse Miss ratio for partic	442	0	0	0	0
OFFICE	Office building-effect coded	442	0.2036199	0.5464256	-1.0000000	1.0000000
REST	Restaurant building-effect coded	442	0.0769231	0.4552157	-1.0000000	1.0000000
RETAIL	Lg & sm retail -eff coded	442	0.0791855	0.4573127	-1.0000000	1.0000000
FOOD	Food store-effect coded	442	0.0090498	0.3808446	-1.0000000	1.0000000
WARE	Refrig & nonref ware -effec coded	442	-0.0248869	0.3324009	-1.0000000	1.0000000
SCHOOL	Primary & sec school-effec code	442	-0.0271493	0.3287929	-1.0000000	1.0000000

CLINIC	Clinic building-effect coded	442	-0.0248869	0.3324009	-1.0000000	1.0000000
HOTLMOTL	Hotel & Motel build-eff coded	442	-0.0452489	0.2977429	-1.0000000	1.0000000
PERSREP	Personal repair serv-eff coded	442	-0.0180995	0.3429074	-1.0000000	1.0000000
COMSERV	Commer services bldg-eff coded	442	0.0248869	0.4004709	-1.0000000	1.0000000
OFFICED	Office building-dummy coded	442	0.2714932	0.4452338	0	1.0000000
RESTD	Restaurant building-dummy coded	442	0.1447964	0.3522942	0	1.0000000
RETAILD	Lg & small retail-dummy coded	442	0.1470588	0.3545659	0	1.0000000
FOODD	Food store building-dummy coded	442	0.0769231	0.2667713	0	1.0000000
WARED	Refrig & nonref ware-dummy coded	442	0.0429864	0.2030563	0	1.0000000
SCHOOLD	Primary & sec sch-dummy coded	442	0.0407240	0.1978740	0	1.0000000
CLINICD	Clinic building-dummy coded	442	0.0429864	0.2030563	0	1.0000000
HOTMOTD	Hotel & Motel-dummy coded	442	0.0226244	0.1488715	0	1.0000000
PERSREPD	Personal repair serv-dummy cd	442	0.0497738	0.2177236	0	1.0000000
COMSERVD	Comm services-dummy coded	442	0.0927602	0.2904248	0	1.0000000
MISCD	Miscellaneous bldg-dummy coded	442	0.0678733	0.2518134	0	1.0000000
OWNBUY	Respondent owns or buying	442	0.4683258	0.4995612	0	1.0000000
RENT	Respondent rents building	442	0.4479638	0.4978484	0	1.0000000
ADCOOLIN	Cool equip added inside prog	442	0	0	0	0
LESHRS	Busin hrs decreased-dummy coded	442	0.0452489	0.2080850	0	1.0000000
MORHRS	Busin hrs increased-dummy coded	442	0.0610860	0.2397593	0	1.0000000
PREMEAN	Mean pre-period cons-comp mos	442	45109.10	152861.43	138.1305555	1785846.84
PSTMEAN	Mean pst-period cons-comp mos	442	44030.81	144496.38	118.6416666	1782160.45
LPREMN	Natural log pre-per mean kwh	442	9.2288275	1.7250151	4.9281993	14.3954033
LPSTMN	Natural log pst-per mean kwh	442	9.2270202	1.7093072	4.7761077	14.3933369
PROPDIF1	difkwhmn div by premean	442	-0.0089929	0.1649522	-1.8706027	0.5985894
PROPDIF2	premean-pstmean by premean	442	-0.0089929	0.1649522	-1.8706027	0.5985894
ADDACOUT	Cool equip added out prog	442	0.0610860	0.2397593	0	1.0000000
ADACOUTP	Cool equip added out prog-part	442	0	0	0	0
COOLSF2	Cooled sqft plug mean bldg type	442	29413.77	58676.09	0	500000.00

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Variable	Label	N	Mean	Std Dev	Minimum	Maximum
PREMID2	Premise ID	438	3258689.94	2106041.17	11405.00	6110120.00
PER1SR	First SR 94 HVAC change	438	93.1255708	19.3796287	25.0000000	99.0000000
PER1SRHN	First SR 94 hvac-nonu chg	438	96.2876712	13.5218912	25.0000000	99.0000000
PER1SRHU	First SR 94 hvac-using chg	438	95.8378995	14.4886518	25.0000000	99.0000000
PER1	First measure for part94	438	29.9018265	4.4027188	12.0000000	43.0000000
PER1HN	First hvac nonus period part94	438	51.8767123	32.5380025	12.0000000	99.0000000
PER1HU	First hvac using period part94	438	68.1301370	34.1467282	20.0000000	99.0000000
NWT2	Expansion weight	438	2.4018265	1.1879096	0.9615502	8.9271098
RWT2	Relative weight	438	1.0000000	0.4945859	0.4003412	3.7168005
PIVOT	Month seq of first install	438	29.9018265	4.4027188	12.0000000	43.0000000
PREKWH1	Month 1 kwh-pre	438	170903.81	867965.27	2.2619048	15039937.50
PREKWH2		438	165790.53	814883.84	2.2619048	13929066.66
PREKWH3		438	170380.88	916259.73	2.2619048	16368683.33
PREKWH4		438	170667.22	884592.78	1.6666667	15780594.82
PREKWH5		438	169387.34	896260.72	1.2298851	16137655.17
PREKWH6		438	174105.21	893298.18	70.9784483	15833125.00
PREKWH7		438	171715.62	905938.83	23.8836207	16480741.66
PREKWH8		438	173919.36	889389.66	47.5270936	15702195.83
PREKWH9		438	169835.39	837493.43	125.5603448	14460627.15
PREKWH10		437	172738.90	870621.10	77.9460270	15284620.69
PREKWH11		373	181826.66	910323.23	129.7023809	14683235.11
PREKWH12	Month 12 kwh-pre	349	178032.51	920725.83	200.4714285	14458521.21
PSTKWH1	Month 1 kwh-pst	438	163320.39	799299.55	87.1212121	13527266.66
PSTKWH2		438	162049.35	778059.57	82.8041958	13099860.21
PSTKWH3		438	161480.42	826236.28	74.9230769	14466220.24
PSTKWH4		437	164003.19	822009.59	74.0000000	14150620.69
PSTKWH5		437	161495.33	810226.53	69.0000000	14051365.52
PSTKWH6		437	159285.78	728923.29	68.9687500	11589725.00
PSTKWH7		437	157237.94	717072.59	63.7312500	11716541.66
PSTKWH8		437	170254.99	765341.67	63.9000000	11889208.33
PSTKWH9		437	164540.45	721700.97	66.2000000	11362538.79
PSTKWH10		437	163010.88	739752.27	0	11668758.62
PSTKWH11		373	168490.41	770500.84	0	11373294.25
PSTKWH12	Month 12 kwh-pst	350	173492.25	804783.62	0	11511775.75
DIFKWHMN	Mean monthly diff in kwh	438	8730.51	139838.91	-289612.50	2812652.37
PREAGG1	Agg kwh btype & SIC mo1 pre	438	61375.15	80099.77	0	358052.25
PREAGG2		438	61604.99	79121.20	0	356465.11
PREAGG3		438	60549.38	77510.21	0	358052.25
PREAGG4		438	61632.61	78301.23	0	356465.11
PREAGG5		438	61848.78	78028.80	0	358052.25
PREAGG6		438	64471.62	82437.32	940.5894718	358052.25
PREAGG7		438	64806.98	82931.04	894.5699882	356465.11
PREAGG8		438	67310.48	87131.76	954.1934219	399598.72
PREAGG9		438	67739.81	88219.43	1034.54	393366.55
PREAGG10		438	66527.80	86905.76	940.5894718	399598.72
PREAGG11		438	65412.76	85785.99	981.2383178	399598.72
PREAGG12	Agg kwh btype & SIC mo12 pre	437	63310.36	83598.34	987.2553476	399598.72
PSTAGG1		438	61973.51	81976.41	1117.35	399598.72
PSTAGG2		438	61424.53	80405.80	1048.12	393366.55
PSTAGG3		438	60338.03	78648.86	947.4838062	399598.72
PSTAGG4		437	61249.32	79024.53	1041.09	393366.55
PSTAGG5		437	61266.11	78508.46	1028.35	399598.72
PSTAGG6		437	63661.20	82470.20	906.6358535	399598.72

PSTAGG7		437	63736.03	82481.17	947.4838062	393366.55
PSTAGG8		437	66444.49	87348.31	943.1306729	399598.72

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Variable	Label	N	Mean	Std Dev	Minimum	Maximum
PSTAGG9		437	66958.58	88045.71	1028.35	393366.55
PSTAGG10		437	65990.43	86695.45	906.6358535	390854.15
PSTAGG11		373	60334.64	82033.07	999.3458226	390854.15
PSTAGG12		350	60514.96	84248.43	943.1306729	390854.15
DIFAGMN	Pre-pst diff in agg kwh	438	656.8836825	10247.10	-118175.97	107881.42
PRECDD1	Month 1 # cool degree days-pre	438	73.0296804	128.4297581	0	549.0000000
PRECDD2		438	71.5753425	125.9152035	0	549.0000000
PRECDD3		438	68.1963470	126.8594162	0	549.0000000
PRECDD4		438	70.5091324	126.0911503	0	691.0000000
PRECDD5		438	77.6894977	123.8159460	0	680.0000000
PRECDD6		438	85.0776256	124.3477202	0	549.0000000
PRECDD7		438	106.0045662	143.2737374	0	599.0000000
PRECDD8		438	114.3904110	172.8379503	0	781.0000000
PRECDD9		438	113.9589041	173.5788669	0	757.0000000
PRECDD10		438	101.1940639	146.3339220	0	647.0000000
PRECDD11		438	81.8219178	137.9992215	0	647.0000000
PRECDD12	Month 12 # cool deg days-pre	437	72.1327231	143.4070544	0	647.0000000
PSTCDD1	Month 1 # cool degree days-pst	438	69.5707763	137.2712268	0	647.0000000
PSTCDD2		438	67.3904110	134.9014238	0	647.0000000
PSTCDD3		438	64.5502283	138.3037515	0	647.0000000
PSTCDD4		437	66.8260870	136.1216467	0	781.0000000
PSTCDD5		437	70.7894737	132.0458864	0	757.0000000
PSTCDD6		437	76.9656751	133.0854944	0	647.0000000
PSTCDD7		437	96.6384439	140.0204021	0	647.0000000
PSTCDD8		437	114.9679634	173.7614068	0	802.0000000
PSTCDD9		437	112.6567506	175.9691155	0	752.0000000
PSTCDD10		437	99.0686499	142.4567369	0	597.0000000
PSTCDD11		373	82.0187668	133.4928904	0	592.0000000
PSTCDD12	Month 12 # cool deg days-pst	350	86.6942857	146.2911519	0	597.0000000
DIFCDDMN	Mean monthly diff in cdd	438	4.2000623	13.2772307	-27.8333333	32.8333333
PREHDD1	Month 1 heating degree days-pre	438	153.5159817	164.7919525	0	584.0000000
PREHDD2		438	137.0365297	150.7130073	0	548.0000000
PREHDD3		438	126.0296804	134.6750527	0	499.0000000
PREHDD4		438	100.8972603	131.6596088	0	527.0000000
PREHDD5		438	100.0684932	133.7384649	0	499.0000000
PREHDD6		438	91.6324201	130.6550283	0	527.0000000
PREHDD7		438	85.9885845	124.9789634	0	499.0000000
PREHDD8		438	82.9634703	130.6302572	0	458.0000000
PREHDD9		438	80.2351598	125.5602072	0	527.0000000
PREHDD10		438	94.5433790	135.2200738	0	527.0000000
PREHDD11		438	99.5251142	145.4626897	0	527.0000000
PREHDD12	Month 12 heat degree days-pre	437	142.4141876	143.8486561	0	499.0000000
PSTHDD1	Month 1 heat degree days-pst	438	168.9703196	169.1500804	0	527.0000000
PSTHDD2		438	132.6118721	140.9568318	0	547.0000000
PSTHDD3		438	119.7077626	134.0829228	0	520.0000000
PSTHDD4		437	113.6544622	136.0425327	0	547.0000000
PSTHDD5		437	104.9656751	130.4686549	0	520.0000000
PSTHDD6		437	89.9977117	123.4595075	0	547.0000000
PSTHDD7		437	88.8352403	124.8969863	0	520.0000000
PSTHDD8		437	84.7139588	128.3594906	0	490.0000000
PSTHDD9		437	85.5560641	125.3361707	0	547.0000000
PSTHDD10		437	102.7368421	143.1410315	0	547.0000000
PSTHDD11		373	119.4584450	151.5868625	0	547.0000000
PSTHDD12	Month 12 heat degree days-pst	350	121.4514286	134.5392932	0	490.0000000
DIFHDDMN	Pre-pst monthly diff in hdd	438	-3.2284523	10.0303905	-30.0000000	19.5000000

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Variable	Label	N	Mean	Std Dev	Minimum	Maximum
PRECPI1	Month 1 consumer price index-pre	438	1.8813392	0.0092142	1.8579620	1.9232740
PRECPI2		438	1.8848442	0.0116543	1.8579620	1.9232740
PRECPI3		438	1.8874824	0.0117721	1.8579620	1.9232740
PRECPI4		438	1.8894898	0.0119802	1.8639830	1.9369700
PRECPI5		438	1.8921973	0.0125676	1.8639830	1.9369700
PRECPI6		438	1.8942028	0.0129104	1.8639830	1.9369700
PRECPI7		438	1.8958158	0.0131866	1.8639830	1.9515870
PRECPI8		438	1.8995613	0.0154777	1.8639830	1.9515870
PRECPI9		438	1.9030893	0.0146385	1.8639830	1.9515870
PRECPI10		438	1.9054011	0.0143677	1.8704860	1.9642430
PRECPI11		438	1.9108050	0.0154532	1.8704860	1.9642430
PRECPI12	Month12 consumer price index-pre	437	1.9143967	0.0150193	1.8736490	1.9642430
PSTCPI1	Month 1 consumer price index-pst	438	1.9168250	0.0150972	1.8704860	1.9735090
PSTCPI2		438	1.9218903	0.0175607	1.8736490	1.9735090
PSTCPI3		438	1.9253961	0.0176997	1.8736490	1.9735090

PSTCPI4		437	1.9279161	0.0178402	1.8736490	1.9515870
PSTCPI5		437	1.9329488	0.0200193	1.8791070	1.9642430
PSTCPI6		437	1.9373431	0.0195206	1.8791070	1.9642430
PSTCPI7		437	1.9403469	0.0193594	1.8791070	1.9642430
PSTCPI8		437	1.9456190	0.0195270	1.8791070	1.9735090
PSTCPI9		437	1.9498950	0.0186349	1.8791070	1.9735090
PSTCPI10		437	1.9527248	0.0181397	1.8791070	1.9735090
PSTCPI11		373	1.9534710	0.0157961	1.8950860	1.9735090
PSTCPI12	Month12 consumer price index-pst	350	1.9565568	0.0145986	1.8950860	1.9735090
DIFCPIMN	Pre-pst diff in cpi	438	-0.0428521	0.0057434	-0.0502350	-0.0153477
PRETAX1	Month 1 taxable sales-pre	438	196.5653952	1.2434675	194.9203000	207.6677000
PRETAX2		438	197.3238473	2.4821813	194.9203000	207.6677000
PRETAX3		438	197.8316475	2.6187995	194.9203000	207.6677000
PRETAX4		438	198.2455000	2.7780964	194.9203000	211.2571000
PRETAX5		438	198.9434016	3.0356532	194.9203000	211.2571000
PRETAX6		438	199.5029400	3.1325496	194.9203000	211.2571000
PRETAX7		438	199.9407573	3.1554496	194.9203000	208.4039000
PRETAX8		438	200.9542952	3.9607227	194.9203000	208.4039000
PRETAX9		438	201.7301205	3.9803618	194.9203000	208.4039000
PRETAX10		438	202.3065847	4.0426341	194.9203000	211.7495000
PRETAX11		438	203.6406959	4.6468570	194.9203000	211.7495000
PRETAX12	Month 12 taxable sales-pre	437	204.7735348	4.4684224	194.9203000	211.7495000
PSTTAX1	Month 1 taxable sales-pst	438	205.5157110	4.4175906	194.9203000	214.2511000
PSTTAX2		438	206.0435080	3.6286204	194.9203000	214.2511000
PSTTAX3		438	206.6573751	3.4325344	194.9203000	214.2511000
PSTTAX4		437	206.9997899	3.2596388	194.9203000	211.2571000
PSTTAX5		437	207.8615046	3.3093243	196.4308000	211.7495000
PSTTAX6		437	208.5450556	2.9552640	196.4308000	211.7495000
PSTTAX7		437	208.9164391	2.7732838	196.4308000	211.7495000
PSTTAX8		437	210.0208140	2.7388254	196.6621000	214.2511000
PSTTAX9		437	210.6816503	2.6237752	196.6621000	214.2511000
PSTTAX10		437	211.1281730	2.5419392	196.6621000	214.2511000
PSTTAX11		373	211.1361960	2.3041080	197.9735000	214.2511000
PSTTAX12	Month 12 taxable sales-pst	350	211.1815743	2.4191670	197.9735000	214.2511000
DIFTAXMN	Pre-pst diff in taxable sales	438	-8.8109358	1.0756327	-9.7951750	1.8853091
PREINC1	Month 1 per capita income-pre	438	17.0809321	4.3421136	11.8851800	26.3040860
PREINC2		438	17.0141361	4.3189504	11.9031500	26.3040860
PREINC3		438	17.0178385	4.3206137	11.9031500	26.3040860
PREINC4		438	17.0060026	4.3064665	11.9031500	26.0912840
PREINC5		438	17.0687910	4.3163355	11.9199800	26.1071890

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Variable	Label	N	Mean	Std Dev	Minimum	Maximum
PREINC6		438	17.0694225	4.3071449	11.9199800	26.1071890
PREINC7		438	17.0685173	4.3080458	11.9199800	26.1071890
PREINC8		438	17.0720925	4.2995423	11.9379400	26.1071890
PREINC9		438	17.0844329	4.3064497	11.9379400	26.1071890
PREINC10		438	17.0955341	4.3255028	11.9379400	26.1071890
PREINC11		438	17.1030075	4.3204947	11.9892500	26.1463860
PREINC12	Month12 per capita income-pre	437	17.0903457	4.3015065	11.9892500	26.1463860
PSTINC1	Month 1 per capita income-pst	438	17.1049441	4.2816742	11.9892500	26.1463860
PSTINC2		438	17.1236563	4.2819318	12.0739100	26.3845780
PSTINC3		438	17.1696667	4.2967843	12.0739100	26.3845780
PSTINC4		437	17.1867518	4.3055649	12.0739100	26.3845780
PSTINC5		437	17.2307019	4.2971822	12.2149400	26.3845780
PSTINC6		437	17.2477267	4.2941314	12.2149400	26.3845780
PSTINC7		437	17.2619648	4.2917509	12.2149400	26.3845780
PSTINC8		437	17.2830621	4.2808771	12.2999900	26.3845780
PSTINC9		437	17.3021669	4.2783512	12.2999900	26.3845780
PSTINC10		437	17.3135772	4.2720374	12.2999900	26.3845780
PSTINC11		373	17.2680292	4.2218162	12.3623700	26.3845780
PSTINC12	Month12 per capita income-pst	350	17.2866936	4.2322206	12.3623700	26.3845780
DIFINCMN	Pre-pst diff in per cap inc	438	-0.1868102	0.2291952	-1.1266000	0.2235803
PREEMP1	Month 1 commer employ-pre	438	233.7711276	209.7171671	18.4665390	601.1497112
PREEMP2		438	233.8860046	209.7690817	18.4665390	601.1497112
PREEMP3		438	234.1435963	209.9560469	18.4665390	601.1497112
PREEMP4		438	234.2258501	209.9720168	18.4665390	601.1497112
PREEMP5		438	234.3951164	209.9984075	18.4665390	601.1497112
PREEMP6		438	234.5443978	210.0348504	18.4665390	601.1497112
PREEMP7		438	234.6644172	210.0825905	18.4665390	601.1497112
PREEMP8		438	234.7248396	209.9686446	18.5544960	601.1497112
PREEMP9		438	234.9045650	210.0284114	18.5544960	601.1497112
PREEMP10		438	235.0049898	210.0450948	18.5544960	601.1497112
PREEMP11		438	235.1110212	209.9757768	18.7494510	601.1497112
PREEMP12	Month 12 commer employ-pre	437	234.6385729	209.8065432	18.7494510	601.1497112
PSTEMP1	Month 1 commer employ-pst	438	235.2374258	209.8288663	18.7494510	601.1497112
PSTEMP2		438	235.4729867	209.9307461	19.1083120	605.4354758
PSTEMP3		438	235.6073189	209.9984527	19.1083120	605.4354758
PSTEMP4		437	235.0628571	209.8770057	19.1083120	605.4354758
PSTEMP5		437	235.1773885	209.9460956	19.3070910	606.5523531
PSTEMP6		437	235.2870396	210.0015303	19.3070910	606.5523531
PSTEMP7		437	235.3652535	210.0727184	19.3070910	606.5523531
PSTEMP8		437	235.6186788	210.1780674	19.4563230	609.2058183
PSTEMP9		437	235.7174784	210.2109875	19.4563230	609.2058183
PSTEMP10		437	235.8503740	210.2835433	19.4563230	609.2058183
PSTEMP11		373	231.8041636	211.8619874	19.5560080	609.2058183

PSTEMP12	Month 12 commer employ-pst	350	232.3312701	211.9828462	19.5560080	609.2058183
DIFEMPMN	Pre-pst diff in employ	438	-1.4277758	1.9064578	-8.1347432	2.1957455
CNTL1	CONTROL NUMBER	438	2922161.86	1988434.85	11405.00	6066814.00
ID1	ID number for interview	438	4519.18	298.8812627	4041.00	5116.00
AUDIT	energy audit	438	2.0000000	0	2.0000000	2.0000000
BTYPE	Bldg type	438	7.1689498	5.1878880	1.0000000	16.0000000
OWN	own or lease	438	1.4634703	0.6609672	1.0000000	3.0000000
BLDGOCC	Who occupies building	384	2.3020833	0.9462836	0	4.0000000
RESPPAYS	respondent pays for elec	438	0.9269406	0.2605315	0	1.0000000
SEPMET2	separate meter dummy	438	0.7853881	0.4110223	0	1.0000000
BLTBEFOR	bldg built before this year	438	1827.68	530.8381775	0	1996.00
GLASPCT2	glass pct approxim	385	29.8103896	21.2295955	0	100.0000000

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Variable	Label	N	Mean	Std Dev	Minimum	Maximum
COOLSF	calc elec cooled sqft	299	52420.15	102489.98	130.0000000	800000.00
HEATSF	calc elec heated sqft	80	26062.15	49275.02	299.0000000	286000.00
WEEKHRS	weekly hrs at survey time	438	76.9851598	43.7876096	4.0000000	168.0000000
SUMPEMS	EMS installatns-pre x fract	438	0.0175038	0.1172208	0	1.0000000
SUMPOEMS	EMS installatns-pst x fract	438	0.0097032	0.0703074	0	0.6666667
SUMPHRS	Chgs in hours-pre x frac	438	0.1636225	3.0338412	-26.2500000	40.3333333
SUMPOHRS	Chgs in hours-pst x frac	438	-0.0125571	2.2044109	-26.2500000	28.5833333
SUMPSQF	Chgs in sqft-pre x fraction	438	828.9535769	11237.91	0	226666.67
SUMPOSQF	Chgs in sqft-pst x fraction	438	42.8177321	643.8974879	-133.3333333	12500.00
SUMSQF	Chgs in sqft-pre+pst x frac	438	871.7713090	11253.26	-133.3333333	226666.67
SUMEMS	EMS install-pre+pst x frac	438	0.0272070	0.1354378	0	1.0000000
SUMHRS	Chgs in hours-pre+pst x frac	438	0.1510654	3.9865387	-52.5000000	40.3333333
SUMPASD	ASD installatns-pre x frac	438	0.0058980	0.0648697	0	1.0000000
SUMPOASD	ASD installatns-pst x frac	438	0	0	0	0
SUMASD	ASD install-pre+pst x frac	438	0.0058980	0.0648697	0	1.0000000
SUMPTIM	Timer install-pre x frac	438	0.0222603	0.1201048	0	1.0000000
SUMPOTIM	Timer install-pst x frac	438	0.0114155	0.0990821	0	1.5000000
SUMTIM	Timer install-pre+pst x frac	438	0.0336758	0.1544674	0	1.5000000
SUMPRC	Cool equip replac-pre x frac	438	0.0030441	0.0463887	0	0.8333333
SUMPORC	Cool equip replac-pst x frac	438	0.0013318	0.0278727	0	0.5833333
SUMRC	Cool equip replacments x frac	438	0.0043760	0.0540433	0	0.8333333
SUMPRCE	Eff cool equip rep-pre x frac	438	0	0	0	0
SUMPORCE	Eff cool equip rep-pst x frac	438	0	0	0	0
SUMRCE	Eff cool equip replac x frac	438	0	0	0	0
SUMPAC	Cool equip added-pre x frac	438	0.0197869	0.1061683	0	0.9166667
SUMPOAC	Cool equip added-pst x frac	438	0.0123668	0.0911960	0	1.0000000
SUMAC	Cool equip added-pre+pst x frac	438	0.0321537	0.1576404	0	1.6666667
SUMPACE	Effic cool equip added x frac	438	0.0015221	0.0318546	0	0.6666667
SUMPOACE	Effic cool equip added x frac	438	0	0	0	0
SUMACE	Effic cool equip added x frac	438	0.0015221	0.0318546	0	0.6666667
SUMPHTG	Heat equip install-pre x frac	438	0.0049467	0.0482428	0	0.5833333
SUMPOHTG	Heat equip install-pst x frac	438	0.000570776	0.0088955	0	0.1666667
SUMHTG	Heat equip install-pre+pstxfrac	438	0.0055175	0.0489983	0	0.5833333
SUMPFRP	Fixture replac-pre x fraction	438	0.5936073	1.8281484	0	6.5000000
SUMPOFRP	Fixture replac-pst x fraction	438	0.5580289	1.7599857	0	6.5000000
SUMFRP	Fixture replac-pre+pst x frac	438	1.1516362	3.5761457	0	13.0000000
SUMPLRP	Lamp replac-pre x fraction	438	4.4866819	2.9896072	0	6.5000000
SUMPOLRP	Lamp replac-pst x fraction	438	4.1078767	2.8730530	0	6.5000000
SUMLRP	Lamp replace-pre+pst x fraction	438	8.5945586	5.7965538	0	13.0000000
SUMPRLI	Light removals-pre x fraction	438	0.0123668	0.0924077	0	0.9166667
SUMPORLI	Light removals-pst x fraction	438	0.0012453	0.0184081	0	0.3636364
SUMRLI	Light removals-pre+pst x fracti	438	0.0136121	0.0969635	0	0.9166667
SUMPELO	Else other install-pre x fract	438	0.1107306	0.8181362	0	6.5000000
SUMPOELO	Else other install-pst x frac	438	0.1033105	0.7709881	0	6.5000000
SUMELO	Else oth install-pre+pst x frac	438	0.2140411	1.5835463	0	13.0000000
SUMPOHT	Oth heat install-pre x frac	438	0.0679224	0.6231765	0	6.5000000
SUMPOOHT	Other heat install-pst x frac	438	0.0614536	0.5687650	0	6.5000000
SUMOHT	Oth heat install-pre+pst x frac	438	0.1293760	1.1811532	0	13.0000000
SUMPLN	Light non-usg instl-prexfrac	438	0.0721081	0.3552361	0	5.6666667
SUMPOLN	Light non-usg instl-prexfrac	438	0.0291096	0.2206434	0	2.7500000
SUMLN	Light non-usg instl-pre+pstxfrac	438	0.1012177	0.4300820	0	5.6666667
SUMPLU	Light usg install-pre x frac	438	0.7817732	2.8238144	0	48.3333333
SUMPOLU	Lightusg install-pst x frac	438	0.2861492	1.4315445	0	21.2500000
SUMLU	Light usg install-pre+pst x frac	438	1.0679224	3.8947792	0	69.5833333
SUMPOT	Other install-pre period x frac	438	0.0329148	0.3309571	0	6.4166667

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Variable	Label	N	Mean	Std Dev	Minimum	Maximum
SUMPOOT	Other install-pst periodxfrac	438	0.0194064	0.2000448	0	3.0000000
SUMOT	Other install-pre+pst x fraction	438	0.0523212	0.3860478	0	6.4166667
SUMPHN	HVAC nonusg-pre period x frac	438	0.0403349	0.2881072	0	3.0833333
SUMPOHN	HVAC nonusg-pst period x frac	438	0.0220700	0.1531141	0	2.0000000
SUMHN	HVAC nonusg-pre+pst period xfrac	438	0.0624049	0.3335329	0	3.3333333
SUMPHU	HVAC ener-usg-pre period x frac	438	0.0291096	0.2561708	0	4.4166667
SUMPOHU	HVAC ener-usg-pst period xfrac	438	0.0106545	0.0913254	0	1.0000000

SUMHU	HVAC enerusg-pre+pst periodxfrac	438	0.0397641	0.2747786	0	4.4166667
CDDM	Pre-pst mean diff cool deg days	438	87.5861353	65.7131314	0.4545455	312.0909091
HDDM	Pre-pst mean diff heat deg days	438	104.7669157	23.3216959	55.0000000	212.7272727
CPIM	Pre-pst mean diff cons price ind	438	1.8949298	0.0123223	1.8638031	1.9421799
EMPM	Pre-pst mean diff employment	438	234.4887205	209.9562099	18.5434109	600.8197904
INCM	Pre-pst mean diff taxable income	438	17.0618825	4.3124959	11.9234218	26.0443642
TAXM	Pre-pst mean diff taxable sales	438	199.7259259	3.0004253	195.9660636	209.5895545
PROBPART	Calc prob of parti-from logit	438	8.4393657E83	1.7662284E85	0.1213989	3.6964422E86
P	probpart div by 1 + probpart	438	0.6032203	0.2029799	0.1082567	1.0000000
MILLS	Inverse Mills ratio	438	1.1269542	0.5659147	1.0062317E-7	3.1670553
MILLS2	Inverse Miss ratio for partic	438	1.1269542	0.5659147	1.0062317E-7	3.1670553
OFFICE	Office building-effect coded	438	0.2808219	0.6021679	-1.0000000	1.0000000
REST	Restaurant building-effect coded	438	-0.0296804	0.3599331	-1.0000000	1.0000000
RETAIL	Lg & sm retail -eff coded	438	0.0136986	0.4168033	-1.0000000	1.0000000
FOOD	Food store-effect coded	438	-0.0593607	0.3116965	-1.0000000	1.0000000
WARE	Refrig & nonref ware -effec coded	438	-0.0296804	0.3599331	-1.0000000	1.0000000
SCHOOL	Primary & sec school-effec code	438	0.0388128	0.4444939	-1.0000000	1.0000000
CLINIC	Clinic building-effect coded	438	-0.0273973	0.3632778	-1.0000000	1.0000000
HOTLMOTL	Hotel & Motel build-eff coded	438	-0.0388128	0.3460803	-1.0000000	1.0000000
PERSREP	Personal repair serv-eff coded	438	-0.0616438	0.3075541	-1.0000000	1.0000000
COMSERV	Commer services bldg-eff coded	438	0.0342466	0.4396959	-1.0000000	1.0000000
OFFICED	Office building-dummy coded	438	0.3607306	0.4807616	0	1.0000000
RESTD	Restaurant building-dummy coded	438	0.0502283	0.2186655	0	1.0000000
RETAILD	Lg & small retail-dummy coded	438	0.0936073	0.2916147	0	1.0000000
FOODD	Food store building-dummy coded	438	0.0205479	0.1420274	0	1.0000000
WARED	Refrig & nonref ware-dummy coded	438	0.0502283	0.2186655	0	1.0000000
SCHOOLD	Primary & sec sch-dummy coded	438	0.1187215	0.3238304	0	1.0000000
CLINICD	Clinic building-dummy coded	438	0.0525114	0.2233110	0	1.0000000
HOTMOTD	Hotel & Motel-dummy coded	438	0.0410959	0.1987390	0	1.0000000
PERSREPD	Personal repair serv-dummy cd	438	0.0182648	0.1340607	0	1.0000000
COMSERVD	Comm services-dummy coded	438	0.1141553	0.3183634	0	1.0000000
MISCD	Miscellaneous bldg-dummy coded	438	0.0799087	0.2714618	0	1.0000000
OWNBUY	Respondent owns or buying	438	0.6301370	0.4833195	0	1.0000000
RENT	Respondent rents building	438	0.2762557	0.4476561	0	1.0000000
ADCOOLIN	Cool equip added inside prog	438	0.0456621	0.2089899	0	1.0000000
LESHRS	Busin hrs decreased-dummy coded	438	0.0228311	0.1495354	0	1.0000000
MORHRS	Busin hrs increased-dummy coded	438	0.0525114	0.2233110	0	1.0000000
PREMEAN	Mean pre-period cons-comp mos	438	170593.29	869953.85	188.1781250	15346583.68
PSTMEAN	Mean pst-period cons-comp mos	438	161863.63	759705.37	67.4848485	12533931.31
LPREMN	Natural log pre-per mean kwh	438	9.8222244	2.0080565	5.2373890	16.5464034
LPSTMN	Natural log pst-per mean kwh	438	9.8057829	1.9799519	4.2119031	16.3439500
PROPDIF1	difkwhmn div by premean	438	-0.0361451	0.6704907	-11.9720419	0.8537935
PROPDIF2	premean-pstmean by premean	438	-0.0363978	0.6703720	-11.9720419	0.8537935
ADDACOUT	Cool equip added out prog	438	0.0593607	0.2365688	0	1.0000000
ADACOUTP	Cool equip added out prog-part	438	0.0593607	0.2365688	0	1.0000000
COOLSF2	Cooled sqft plug mean bldg type	438	51487.88	90528.65	130.0000000	800000.00

F.2 Model Specifications and Diagnostics

Shown below are the model specifications and diagnostics for a series of models which were tested. The final model selected for estimating net program savings is the eighth model. For each model specification, results are shown for various dependent variables and for sub-models estimated using cases associated with energy-using technologies (C Total DF = 168) or non-energy using technologies (C Total DF = 738). Also shown are specifications involving all cases (C Total DF = 876).

First model specification

The SAS System 4
11:18 Sunday, March 3, 1996

Model: MODEL1
Dependent Variable: LPSTMN

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	18	552.63606	30.70200	657.259	0.0001
Error	150	7.00682	0.04671		
C Total	168	559.64288			

Root MSE	0.21613	R-square	0.9875
Dep Mean	9.34000	Adj R-sq	0.9860
C.V.	2.31402		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-0.181983	0.10503357	-1.733	0.0852
LPREMN	1	1.020746	0.01034406	98.679	0.0001
PART2	1	-0.110894	0.06177090	-1.795	0.0746
DIFHDDMN	1	-0.004750	0.00181533	-2.616	0.0098
DIFCDDMN	1	0.000494	0.00130557	0.378	0.7058
SUMHRS	1	0.005763	0.00361161	1.596	0.1127
SUMSQF	1	0.000013355	0.00001257	1.062	0.2898
ANYSR	1	0.195364	0.06097561	3.204	0.0017
DIFAGMN	1	0.000001174	0.00000161	0.731	0.4660
OFFICE	1	-0.009725	0.03649994	-0.266	0.7903
REST	1	0.005648	0.06027498	0.094	0.9255
RETAIL	1	0.002043	0.05475145	0.037	0.9703
FOOD	1	-0.016729	0.08301834	-0.202	0.8406
WARE	1	0.160566	0.07192317	2.232	0.0271
SCHOOL	1	0.018255	0.04779025	0.382	0.7030
CLINIC	1	0.064667	0.06273034	1.031	0.3043
HOTLMOTL	1	0.005663	0.10394983	0.054	0.9566
PERSREP	1	0.091465	0.10071451	0.908	0.3652
COMSERV	1	-0.027551	0.05618004	-0.490	0.6246

The SAS System 5
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Model: MODEL2
Dependent Variable: PSTMEAN

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	18	2.3458456E13	1.3032476E12	5726.968	0.0001
Error	150	34134487451	227563249.67		
C Total	168	2.349259E13			

Root MSE	15085.19969	R-square	0.9985
Dep Mean	81212.45164	Adj R-sq	0.9984
C.V.	18.57498		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	164.329902	4106.4646794	0.040	0.9681
PREMEAN	1	1.014729	0.00331860	305.771	0.0001
PART2	1	-4118.190300	4242.0033269	-0.971	0.3332
DIFHDDMN	1	-22.540650	124.46919659	-0.181	0.8565
DIFCDDMN	1	-2.824810	89.76276178	-0.031	0.9749
SUMHRS	1	58.739232	250.93829148	0.234	0.8152
SUMSQF	1	1.841505	0.87428972	2.106	0.0368
ANYSR	1	4603.272024	4305.7353274	1.069	0.2867
DIFAGMN	1	-0.037536	0.11197377	-0.335	0.7379
OFFICE	1	1283.529907	2550.9388664	0.503	0.6156
REST	1	2200.356735	4210.0773682	0.523	0.6020
RETAIL	1	-2120.779541	3818.3908959	-0.555	0.5794
FOOD	1	-133.241210	5791.6719060	-0.023	0.9817
WARE	1	2700.321437	5018.6161698	0.538	0.5913
SCHOOL	1	545.651218	3328.0637563	0.164	0.8700
CLINIC	1	1077.563748	4382.8245904	0.246	0.8061
HOTLMOTL	1	-3303.427305	7175.6136441	-0.460	0.6459
PERSREP	1	3728.289287	6914.8273724	0.539	0.5906
COMSERV	1	146.017079	3919.3831228	0.037	0.9703

The SAS System 6
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Model: MODEL1
Dependent Variable: LPSTMN

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	18	2389.28353	132.73797	2344.945	0.0001
Error	720	40.75633	0.05661		
C Total	738	2430.03986			

Root MSE	0.23792	R-square	0.9832
Dep Mean	8.23901	Adj R-sq	0.9828
C.V.	2.88773		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	0.345418	0.04919610	7.021	0.0001
LPREMN	1	0.958632	0.00586595	163.423	0.0001
PART2	1	0.067546	0.02133041	3.167	0.0016
DIFHDDMN	1	0.000669	0.00106450	0.628	0.5301

DIFCDDMN	1	0.000424	0.00083552	0.507	0.6120
SUMHRS	1	0.001522	0.00289333	0.526	0.5991
SUMSQF	1	0.000002129	0.00000122	1.744	0.0816
ANYSR	1	0.031656	0.05941213	0.533	0.5943
DIFAGMN	1	-0.000000846	0.00000077	-1.103	0.2702
OFFICE	1	-0.017806	0.01837721	-0.969	0.3329
REST	1	-0.027730	0.03072467	-0.903	0.3671
RETAIL	1	0.014124	0.02625469	0.538	0.5908
FOOD	1	0.051707	0.05994150	0.863	0.3886
WARE	1	0.065683	0.03827445	1.716	0.0866
SCHOOL	1	-0.028408	0.04163278	-0.682	0.4952
CLINIC	1	0.039963	0.04823738	0.828	0.4077
HOTLMOTL	1	-0.019957	0.05088547	-0.392	0.6950
PERSREP	1	-0.023284	0.03296230	-0.706	0.4802
COMSERV	1	-0.032154	0.02818606	-1.141	0.2543

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Model: MODEL2
Dependent Variable: PSTMEAN

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	18	2.6945165E13	1.4969536E12	4255.082	0.0001
Error	720	253298686900	351803731.81		
C Total	738	2.7198464E13			

Root MSE	18756.43175	R-square	0.9907
Dep Mean	36960.53150	Adj R-sq	0.9905
C.V.	50.74719		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	355.468803	1241.2607887	0.286	0.7747
PREMEAN	1	0.941182	0.00365547	257.472	0.0001
PART2	1	-21.413159	1525.0076755	-0.014	0.9888
DIFHDDMN	1	-164.474154	83.86348246	-1.961	0.0502
DIFCDDMN	1	86.117569	65.91540987	1.306	0.1918
SUMHRS	1	-127.636203	227.97891821	-0.560	0.5757
SUMSQF	1	1.501711	0.09682877	15.509	0.0001
ANYSR	1	19236	4700.3324959	4.092	0.0001
DIFAGMN	1	-0.024447	0.06040417	-0.405	0.6858
OFFICE	1	-3327.931771	1413.2133681	-2.355	0.0188
REST	1	-1349.260179	2423.0303006	-0.557	0.5778
RETAIL	1	-1815.226551	2066.7850186	-0.878	0.3801
FOOD	1	-1634.362512	4654.2414161	-0.351	0.7256
WARE	1	453.617346	3018.7990237	0.150	0.8806
SCHOOL	1	-2330.059560	3283.2470086	-0.710	0.4781
CLINIC	1	1750.402920	3769.8184812	0.464	0.6426
HOTLMOTL	1	478.665092	4013.5462781	0.119	0.9051
PERSREP	1	-863.272160	2531.3094384	-0.341	0.7332
COMSERV	1	2761.482924	2215.5095048	1.246	0.2130

The SAS System 8
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Model: MODEL1
Dependent Variable: LPSTMN

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	18	3081.62055	171.20114	2917.349	0.0001
Error	858	50.35070	0.05868		
C Total	876	3131.97126			

Root MSE	0.24225	R-square	0.9839
Dep Mean	8.44641	Adj R-sq	0.9836
C.V.	2.86805		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	0.231737	0.04378310	5.293	0.0001
LPREMN	1	0.972333	0.00520309	186.876	0.0001
PART2	1	0.018356	0.01943207	0.945	0.3451
DIFHDDMN	1	-0.001140	0.00094929	-1.201	0.2302
DIFCDDMN	1	-0.000054457	0.00072655	-0.075	0.9403
SUMHRS	1	0.002792	0.00237964	1.173	0.2409
SUMSQF	1	0.000002096	0.00000123	1.698	0.0898
ANYSR	1	0.058474	0.04330817	1.350	0.1773

```
      DIFAGMN    1  -0.000000712    0.00000071        -1.002        0.3166
      OFFICE     1     -0.007584    0.01674597        -0.453        0.6507
      REST       1     -0.010477    0.02873385        -0.365        0.7155
      RETAIL     1      0.013089    0.02426139         0.539        0.5897
      FOOD       1      0.002224    0.05184275         0.043        0.9658
      WARE       1      0.069633    0.03563744         1.954        0.0510
      SCHOOL     1     -0.016434    0.03200423        -0.513        0.6077
      CLINIC     1      0.031092    0.03988833         0.779        0.4359
      HOTLMOTL   1     -0.001412    0.04613581        -0.031        0.9756
      PERSREP    1     -0.008116    0.03177994        -0.255        0.7985
      COMSERV    1     -0.021486    0.02599227        -0.827        0.4087

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Model: MODEL2
Dependent Variable: PSTMEAN

                        Analysis of Variance

                               Sum of         Mean
        Source          DF      Squares       Square      F Value       Prob>F

        Model           18 5.0575793E13 2.8097663E12     6836.543       0.0001
        Error          858 352631364505 410992266.32
        C Total        876 5.0928424E13

            Root MSE   20272.94419     R-square       0.9931
            Dep Mean   45928.03911     Adj R-sq       0.9929
            C.V.          44.14067

                        Parameter Estimates

                       Parameter      Standard    T for H0:
      Variable  DF      Estimate         Error   Parameter=0    Prob > |T|

      INTERCEP   1     57.276516  1258.0787471         0.046        0.9637
      PREMEAN    1      0.973840    0.00294338       330.857        0.0001
      PART2      1  -1515.181364  1468.3702591        -1.032        0.3024
      DIFHDDMN   1   -119.388092   79.57960590        -1.500        0.1339
      DIFCDDMN   1     68.451985   60.85166808         1.125        0.2609
      SUMHRS     1    -74.389449  199.08066298        -0.374        0.7087
      SUMSQF     1      1.383027    0.10352850        13.359        0.0001
      ANYSR      1         13205  3675.3064270         3.593        0.0003
      DIFAGMN    1     -0.014547    0.05944869        -0.245        0.8067
      OFFICE     1  -2440.306518  1376.3663213        -1.773        0.0766
      REST       1   -564.461568  2405.6151251        -0.235        0.8145
      RETAIL     1  -1553.722231  2028.6711868        -0.766        0.4440
      FOOD       1  -2435.038047  4296.0797712        -0.567        0.5710
      WARE       1   1395.999004  2983.2955261         0.468        0.6399
      SCHOOL     1   -769.314615  2677.2495341        -0.287        0.7739
      CLINIC     1      9.226097  3324.5162438         0.003        0.9978
      HOTLMOTL   1   1043.833322  3857.9384693         0.271        0.7868
      PERSREP    1   -274.676525  2597.3266292        -0.106        0.9158
      COMSERV    1   1799.983067  2167.6378291         0.830        0.4065
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Second model specification

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                           The SAS System                               10
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Model: MODEL1
Dependent Variable: LPSTMN

                        Analysis of Variance

                               Sum of         Mean
        Source          DF      Squares       Square      F Value       Prob>F

        Model            8    551.50861     68.93858     1356.012       0.0001
        Error          160      8.13428      0.05084
        C Total        168    559.64288

            Root MSE       0.22548     R-square       0.9855
            Dep Mean       9.34000     Adj R-sq       0.9847
            C.V.           2.41408

                        Parameter Estimates

                       Parameter      Standard    T for H0:
      Variable  DF      Estimate         Error   Parameter=0    Prob > |T|

      INTERCEP   1     -0.254425    0.10413051        -2.443        0.0156
      LPREMN     1      1.020422    0.01046210        97.535        0.0001
      PART2      1     -0.034202    0.05911477        -0.579        0.5637
      DIFHDDMN   1     -0.004064    0.00179874        -2.260        0.0252
      DIFCDDMN   1      0.001256    0.00130383         0.963        0.3370
      SUMHRS     1      0.008307    0.00364902         2.277        0.0241
      SUMSQF     1   0.000011369    0.00001267         0.898        0.3708
      ANYSR      1      0.159282    0.05993081         2.658        0.0087
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     DIFAGMN    1   0.000000132    0.00000161         0.082        0.9349

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Model: MODEL2
Dependent Variable: PSTMEAN

                              Analysis of Variance

                                 Sum of         Mean
       Source          DF      Squares       Square      F Value       Prob>F

       Model            8 2.3457733E13 2.9322166E12    13459.319       0.0001
       Error          160  34857236457 217857727.85
       C Total        168  2.349259E13

           Root MSE   14760.00433     R-square       0.9985
           Dep Mean   81212.45164     Adj R-sq       0.9984
           C.V.          18.17456

                              Parameter Estimates

                      Parameter      Standard    T for H0:
     Variable  DF      Estimate         Error   Parameter=0    Prob > |T|

     INTERCEP   1   -819.956074  3648.8275211        -0.225        0.8225
     PREMEAN    1      1.014167    0.00320371       316.561        0.0001
     PART2      1  -2798.568427  3787.6667820        -0.739        0.4611
     DIFHDDMN   1      9.998788  116.00557654         0.086        0.9314
     DIFCDDMN   1     28.255799   83.79479852         0.337        0.7364
     SUMHRS     1    104.066500  238.54766657         0.436        0.6632
     SUMSQF     1      1.785119    0.82408087         2.166        0.0318
     ANYSR      1   4746.704932  3976.0754866         1.194        0.2343
     DIFAGMN    1     -0.036772    0.10536219        -0.349        0.7275

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Model: MODEL1
Dependent Variable: LPSTMN

                              Analysis of Variance

                                 Sum of         Mean
       Source          DF      Squares       Square      F Value       Prob>F

       Model            8   2388.83483    298.60435     5290.160       0.0001
       Error          730     41.20503      0.05645
       C Total        738   2430.03986

           Root MSE       0.23758     R-square       0.9830
           Dep Mean       8.23901     Adj R-sq       0.9829
           C.V.           2.88362

                              Parameter Estimates

                      Parameter      Standard    T for H0:
     Variable  DF      Estimate         Error   Parameter=0    Prob > |T|

     INTERCEP   1      0.313908    0.04335897         7.240        0.0001
     LPREMN     1      0.961230    0.00552282       174.047        0.0001
     PART2      1      0.064424    0.02068365         3.115        0.0019
     DIFHDDMN   1      0.000371    0.00105446         0.352        0.7253
     DIFCDDMN   1      0.000482    0.00080651         0.598        0.5500
     SUMHRS     1      0.001804    0.00284595         0.634        0.5263
     SUMSQF     1   0.000001992    0.00000121         1.646        0.1001
     ANYSR      1      0.026009    0.05708845         0.456        0.6488
     DIFAGMN    1  -0.000000950    0.00000076        -1.246        0.2133

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Model: MODEL2
Dependent Variable: PSTMEAN

                              Analysis of Variance

                                 Sum of         Mean
       Source          DF      Squares       Square      F Value       Prob>F

       Model            8 2.6940072E13  3.367509E12     9513.781       0.0001
       Error          730 258391663026 353961182.23
       C Total        738 2.7198464E13

           Root MSE   18813.85612     R-square       0.9905
           Dep Mean   36960.53150     Adj R-sq       0.9904
           C.V.          50.90256

                              Parameter Estimates

                      Parameter      Standard    T for H0:
```

Variable	DF	Estimate	Error	Parameter=0	Prob > |T|
INTERCEP	1	-633.341167	1003.4634596	-0.631	0.5281
PREMEAN	1	0.941903	0.00364367	258.504	0.0001
PART2	1	321.497830	1472.9487316	0.218	0.8273
DIFHDDMN	1	-156.997182	83.50559159	-1.880	0.0605
DIFCDDMN	1	47.781152	63.88893276	0.748	0.4548
SUMHRS	1	-30.914189	225.24620831	-0.137	0.8909
SUMSQF	1	1.530966	0.09658333	15.851	0.0001
ANYSR	1	19591	4521.4046186	4.333	0.0001
DIFAGMN	1	-0.031674	0.06033858	-0.525	0.5998

The SAS System 14
11:18 Sunday, March 3, 1996

Model: MODEL1
Dependent Variable: LPSTMN

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	8	3081.16030	385.14504	6579.405	0.0001
Error	868	50.81096	0.05854		
C Total	876	3131.97126			

Root MSE	0.24195	R-square	0.9838
Dep Mean	8.44641	Adj R-sq	0.9836
C.V.	2.86449		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	0.220158	0.03926878	5.606	0.0001
LPREMN	1	0.973034	0.00495706	196.293	0.0001
PART2	1	0.019036	0.01899398	1.002	0.3165
DIFHDDMN	1	-0.001259	0.00094232	-1.336	0.1819
DIFCDDMN	1	0.000074219	0.00070582	0.105	0.9163
SUMHRS	1	0.002887	0.00235953	1.224	0.2214
SUMSQF	1	0.000001856	0.00000122	1.515	0.1301
ANYSR	1	0.055216	0.04249143	1.299	0.1941
DIFAGMN	1	-0.000000840	0.00000070	-1.193	0.2334

The SAS System 15
11:18 Sunday, March 3, 1996

Model: MODEL2
Dependent Variable: PSTMEAN

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	8	5.0572827E13	6.3216034E12	15430.814	0.0001
Error	868	355597028766	409673996.27		
C Total	876	5.0928424E13			

Root MSE	20240.40504	R-square	0.9930
Dep Mean	45928.03911	Adj R-sq	0.9930
C.V.	44.06982		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-675.344538	1052.8717330	-0.641	0.5214
PREMEAN	1	0.974075	0.00292062	333.517	0.0001
PART2	1	-1319.623941	1408.0158164	-0.937	0.3489
DIFHDDMN	1	-115.668551	78.97360798	-1.465	0.1434
DIFCDDMN	1	43.131668	59.11909313	0.730	0.4658
SUMHRS	1	-39.712520	197.35810639	-0.201	0.8406
SUMSQF	1	1.403167	0.10281110	13.648	0.0001
ANYSR	1	13688	3603.7982721	3.798	0.0002
DIFAGMN	1	-0.024113	0.05891005	-0.409	0.6824

Third model specification

The SAS System 16
11:18 Sunday, March 3, 1996

Model: MODEL1
Dependent Variable: LRATIO

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	7	1.04449	0.14921	2.885	0.0073
Error	161	8.32798	0.05173		
C Total	168	9.37247			

Root MSE	0.22743	R-square	0.1114
Dep Mean	-0.04879	Adj R-sq	0.0728
C.V.	-466.15490		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-0.082736	0.05622177	-1.472	0.1431
PART2	1	-0.010007	0.05830287	-0.172	0.8639
DIFHDDMN	1	-0.004724	0.00178203	-2.651	0.0088
DIFCDDMN	1	0.000741	0.00128796	0.575	0.5660
SUMHRS	1	0.007673	0.00366608	2.093	0.0379
SUMSQF	1	0.000014537	0.00001267	1.147	0.2530
ANYSR	1	0.146715	0.06010172	2.441	0.0157
DIFAGMN	1	0.000000220	0.00000162	0.136	0.8923

The SAS System 17
11:18 Sunday, March 3, 1996

Model: MODEL2
Dependent Variable: DIFKWHMN

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	7	2517358525.4	359622646.49	1.480	0.1778
Error	161	39117205960	242964012.17		
C Total	168	41634564485			

Root MSE	15587.30292	R-square	0.0605
Dep Mean	1028.95556	Adj R-sq	0.0196
C.V.	1514.86648		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	667.816180	3853.1730857	0.173	0.8626
PART2	1	2034.564851	3995.8020207	0.509	0.6113
DIFHDDMN	1	30.156761	122.13176776	0.247	0.8053
DIFCDDMN	1	-2.077706	88.27038156	-0.024	0.9813
SUMHRS	1	-27.597427	251.25545865	-0.110	0.9127
SUMSQF	1	-2.019162	0.86847386	-2.325	0.0213
ANYSR	1	-8159.211957	4119.0868876	-1.981	0.0493
DIFAGMN	1	0.028790	0.11125141	0.259	0.7961

The SAS System 18
11:18 Sunday, March 3, 1996

Model: MODEL1
Dependent Variable: LRATIO

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	7	0.19631	0.02804	0.466	0.8593
Error	731	43.98657	0.06017		
C Total	738	44.18289			

Root MSE	0.24530	R-square	0.0044
Dep Mean	0.02240	Adj R-sq	-0.0051
C.V.	1094.95188		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	0.022816	0.01308092	1.744	0.0815
PART2	1	-0.001999	0.01899012	-0.105	0.9162
DIFHDDMN	1	-0.000020535	0.00108720	-0.019	0.9849
DIFCDDMN	1	0.000292	0.00083224	0.351	0.7260
SUMHRS	1	0.002479	0.00293675	0.844	0.3989
SUMSQF	1	0.000001141	0.00000124	0.918	0.3590
ANYSR	1	-0.047489	0.05794374	-0.820	0.4127
DIFAGMN	1	-0.000000737	0.00000079	-0.937	0.3493

The SAS System 19

11:18 Sunday, March 3, 1996

Model: MODEL2
Dependent Variable: DIFKWHMN

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	7	68183557846	9740508263.8	20.383	0.0001
Error	731	349325374932	477873289.92		
C Total	738	417508932778			

Root MSE	21860.31312	R-square	0.1633
Dep Mean	948.92603	Adj R-sq	0.1553
C.V.	2303.68991		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	962.911349	1165.7174381	0.826	0.4091
PART2	1	3175.531965	1692.3208378	1.876	0.0610
DIFHDDMN	1	87.416198	96.88695218	0.902	0.3672
DIFCDDMN	1	-91.669430	74.16609232	-1.236	0.2169
SUMHRS	1	1.692325	261.71096439	0.006	0.9948
SUMSQF	1	-1.285400	0.11078903	-11.602	0.0001
ANYSR	1	-6307.929182	5163.7061826	-1.222	0.2223
DIFAGMN	1	0.018872	0.07010242	0.269	0.7879

The SAS System 20
11:18 Sunday, March 3, 1996

Model: MODEL1
Dependent Variable: LRATIO

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	7	0.56394	0.08056	1.332	0.2316
Error	869	52.54324	0.06046		
C Total	876	53.10717			

Root MSE	0.24589	R-square	0.0106
Dep Mean	0.01010	Adj R-sq	0.0026
C.V.	2434.17632		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	0.017807	0.01278966	1.392	0.1642
PART2	1	-0.030181	0.01697328	-1.778	0.0757
DIFHDDMN	1	-0.001293	0.00095767	-1.350	0.1772
DIFCDDMN	1	0.000118	0.00071729	0.165	0.8692
SUMHRS	1	0.003363	0.00239640	1.403	0.1609
SUMSQF	1	0.000001271	0.00000124	1.025	0.3056
ANYSR	1	0.030993	0.04294704	0.722	0.4707
DIFAGMN	1	-0.000000688	0.00000072	-0.962	0.3364

The SAS System 21
11:18 Sunday, March 3, 1996

Model: MODEL2
Dependent Variable: DIFKWHMN

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	7	70126264303	10018037758	22.390	0.0001
Error	869	388826037060	447440779.13		
C Total	876	458952301363			

Root MSE	21152.79601	R-square	0.1528
Dep Mean	977.67814	Adj R-sq	0.1460
C.V.	2163.57462		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	818.375155	1100.2168492	0.744	0.4572
PART2	1	2866.888484	1460.1084034	1.963	0.0499
DIFHDDMN	1	74.874685	82.38285661	0.909	0.3637

DIFCDDMN	1	-70.037828	61.70388511	-1.135	0.2567
SUMHRS	1	-16.946734	206.14731087	-0.082	0.9345
SUMSQF	1	-1.292219	0.10665076	-12.116	0.0001
ANYSR	1	-7466.449896	3694.4729220	-2.021	0.0436
DIFAGMN	1	0.019433	0.06156287	0.316	0.7523

Fourth model specification

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                          The SAS System                                 22
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Model: MODEL1
Dependent Variable: LRATIO
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Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	17	2.17775	0.12810	2.689	0.0007
Error	151	7.19472	0.04765		
C Total	168	9.37247			

Root MSE	0.21828	R-square	0.2324
Dep Mean	-0.04879	Adj R-sq	0.1459
C.V.	-447.39577		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-0.007451	0.05940148	-0.125	0.9003
PART2	1	-0.086890	0.06120385	-1.420	0.1578
DIFHDDMN	1	-0.005482	0.00179592	-3.053	0.0027
DIFCDDMN	1	0.000011050	0.00129597	0.009	0.9932
SUMHRS	1	0.004973	0.00362581	1.371	0.1723
SUMSQF	1	0.000016093	0.00001262	1.275	0.2043
ANYSR	1	0.184792	0.06135231	3.012	0.0030
DIFAGMN	1	0.000001349	0.00000162	0.833	0.4063
OFFICE	1	-0.010649	0.03686049	-0.289	0.7730
REST	1	0.004312	0.06087152	0.071	0.9436
RETAIL	1	-0.002984	0.05523871	-0.054	0.9570
FOOD	1	-0.010808	0.08379205	-0.129	0.8975
WARE	1	0.164057	0.07261815	2.259	0.0253
SCHOOL	1	0.025415	0.04813133	0.528	0.5983
CLINIC	1	0.066351	0.06334937	1.047	0.2966
HOTLMOTL	1	0.038161	0.10370175	0.368	0.7134
PERSREP	1	0.054739	0.10002206	0.547	0.5850
COMSERV	1	-0.033248	0.05666695	-0.587	0.5583

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                          The SAS System                                 23
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Model: MODEL2
Dependent Variable: DIFKWHMN
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Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	17	3017195976.4	177482116.26	0.694	0.8053
Error	151	38617368509	255744162.31		
C Total	168	41634564485			

Root MSE	15992.00307	R-square	0.0725
Dep Mean	1028.95556	Adj R-sq	-0.0320
C.V.	1554.19764		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	295.587344	4351.9267866	0.068	0.9459
PART2	1	2686.218187	4483.9736587	0.599	0.5500
DIFHDDMN	1	64.279086	131.57416805	0.489	0.6259
DIFCDDMN	1	29.413581	94.94643788	0.310	0.7571
SUMHRS	1	1.159990	265.63772874	0.004	0.9965
SUMSQF	1	-2.101101	0.92476882	-2.272	0.0245
ANYSR	1	-7930.472833	4494.8503880	-1.764	0.0797
DIFAGMN	1	0.034906	0.11870309	0.294	0.7691
OFFICE	1	-1881.433502	2700.5078247	-0.697	0.4871
REST	1	-1457.490024	4459.6257206	-0.327	0.7443
RETAIL	1	2492.221093	4046.9501374	0.616	0.5389
FOOD	1	590.236277	6138.8512705	0.096	0.9235
WARE	1	-2580.392308	5320.2187296	-0.485	0.6284
SCHOOL	1	-63.716694	3526.2424274	-0.018	0.9856
CLINIC	1	-164.168165	4641.1607642	-0.035	0.9718

HOTLMOTL	1	1715.554663	7597.4946243	0.226	0.8217
PERSREP	1	-2913.610303	7327.9092657	-0.398	0.6915
COMSERV	1	557.422634	4151.5871182	0.134	0.8934

The SAS System 24
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Model: MODEL1
Dependent Variable: LRATIO

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	17	0.61126	0.03596	0.595	0.8973
Error	721	43.57163	0.06043		
C Total	738	44.18289			

Root MSE	0.24583	R-square	0.0138
Dep Mean	0.02240	Adj R-sq	-0.0094
C.V.	1097.30643		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	0.016717	0.01626699	1.028	0.3044
PART2	1	0.001163	0.01977749	0.059	0.9531
DIFHDDMN	1	0.000202	0.00109776	0.184	0.8542
DIFCDDMN	1	0.000330	0.00086319	0.382	0.7024
SUMHRS	1	0.002215	0.00298779	0.741	0.4587
SUMSQF	1	0.000001260	0.00000125	1.004	0.3155
ANYSR	1	-0.038074	0.06053117	-0.629	0.5296
DIFAGMN	1	-0.000000661	0.00000079	-0.835	0.4039
OFFICE	1	0.010763	0.01852107	0.581	0.5613
REST	1	-0.028057	0.03174605	-0.884	0.3771
RETAIL	1	0.024193	0.02708737	0.893	0.3721
FOOD	1	-0.022508	0.06097225	-0.369	0.7121
WARE	1	0.072024	0.03953594	1.822	0.0689
SCHOOL	1	-0.032013	0.04301358	-0.744	0.4570
CLINIC	1	-0.005555	0.04939282	-0.112	0.9105
HOTLMOTL	1	-0.014328	0.05257065	-0.273	0.7853
PERSREP	1	0.029484	0.03316904	0.889	0.3744
COMSERV	1	-0.016817	0.02903626	-0.579	0.5627

The SAS System 25
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Model: MODEL2
Dependent Variable: DIFKWHMN

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	17	72190163439	4246480202.3	8.866	0.0001
Error	721	345318769339	478944201.58		
C Total	738	417508932778			

Root MSE	21884.79384	R-square	0.1729
Dep Mean	948.92603	Adj R-sq	0.1534
C.V.	2306.26974		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-72.865261	1448.1562295	-0.050	0.9599
PART2	1	3563.914284	1760.6752597	2.024	0.0433
DIFHDDMN	1	98.804606	97.72751762	1.011	0.3123
DIFCDDMN	1	-130.070885	76.84455063	-1.693	0.0910
SUMHRS	1	86.114784	265.98604834	0.324	0.7462
SUMSQF	1	-1.268184	0.11170198	-11.353	0.0001
ANYSR	1	-5170.711834	5388.7407445	-0.960	0.3376
DIFAGMN	1	0.008677	0.07046916	0.123	0.9020
OFFICE	1	3575.744050	1648.8236777	2.169	0.0304
REST	1	311.917603	2826.1676672	0.110	0.9121
RETAIL	1	1563.920056	2411.4317924	0.649	0.5168
FOOD	1	3914.308990	5428.0075480	0.721	0.4711
WARE	1	-2333.882067	3519.6567700	-0.663	0.5075
SCHOOL	1	798.313222	3829.2508170	0.208	0.8349
CLINIC	1	-201.073450	4397.1570502	-0.046	0.9635
HOTLMOTL	1	-2758.255989	4680.0614752	-0.589	0.5558
PERSREP	1	2.778671	2952.8477041	0.001	0.9992
COMSERV	1	-2500.576771	2584.9307340	-0.967	0.3337

The SAS System 26
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Model: MODEL1
Dependent Variable: LRATIO

                          Analysis of Variance

                             Sum of         Mean
       Source          DF      Squares       Square      F Value       Prob>F

       Model           17      1.09721      0.06454        1.066       0.3832
       Error          859     52.00996      0.06055
       C Total        876     53.10717

           Root MSE       0.24606     R-square       0.0207
           Dep Mean       0.01010     Adj R-sq       0.0013
           C.V.        2435.84799

                          Parameter Estimates

                     Parameter      Standard    T for H0:
     Variable  DF      Estimate         Error   Parameter=0    Prob > |T|

     INTERCEP   1      0.013079    0.01526984         0.857        0.3920
     PART2      1     -0.027506    0.01768743        -1.555        0.1203
     DIFHDDMN   1     -0.001176    0.00096422        -1.220        0.2228
     DIFCDDMN   1   0.000032697    0.00073781         0.044        0.9647
     SUMHRS     1      0.003264    0.00241545         1.351        0.1770
     SUMSQF     1   0.000001534    0.00000125         1.229        0.2195
     ANYSR      1      0.036882    0.04379657         0.842        0.4000
     DIFAGMN    1  -0.000000613    0.00000072        -0.849        0.3959
     OFFICE     1      0.009295    0.01670137         0.557        0.5780
     REST       1     -0.010720    0.02918642        -0.367        0.7135
     RETAIL     1      0.018412    0.02462256         0.748        0.4548
     FOOD       1     -0.036435    0.05213897        -0.699        0.4849
     WARE       1      0.073061    0.03619287         2.019        0.0438
     SCHOOL     1     -0.023163    0.03248293        -0.713        0.4760
     CLINIC     1      0.011953    0.04035133         0.296        0.7671
     HOTLMOTL   1     -0.011429    0.04682345        -0.244        0.8072
     PERSREP    1      0.028350    0.03151997         0.899        0.3687
     COMSERV    1     -0.009952    0.02630959        -0.378        0.7053

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Model: MODEL2
Dependent Variable: DIFKWHMN

                          Analysis of Variance

                             Sum of         Mean
       Source          DF      Squares       Square      F Value       Prob>F

       Model           17  72912630481 4288978263.6        9.544       0.0001
       Error          859 386039670882 449405903.24
       C Total        876 458952301363

           Root MSE   21199.19582     R-square       0.1589
           Dep Mean     977.67814     Adj R-sq       0.1422
           C.V.        2168.32054

                          Parameter Estimates

                     Parameter      Standard    T for H0:
     Variable  DF      Estimate         Error   Parameter=0    Prob > |T|

     INTERCEP   1     -5.803992  1315.5497258        -0.004        0.9965
     PART2      1   3115.210586  1523.8334247         2.044        0.0412
     DIFHDDMN   1     79.261759   83.07057703         0.954        0.3403
     DIFCDDMN   1    -93.537489   63.56491992        -1.472        0.1415
     SUMHRS     1     26.412268  208.09904396         0.127        0.8990
     SUMSQF     1     -1.280602    0.10758492       -11.903        0.0001
     ANYSR      1  -6990.337823  3773.2256108        -1.853        0.0643
     DIFAGMN    1      0.007980    0.06215965         0.128        0.8979
     OFFICE     1   2717.051752  1438.8803942         1.888        0.0593
     REST       1    -43.340699  2514.5111896        -0.017        0.9863
     RETAIL     1   1443.666513  2121.3183259         0.681        0.4963
     FOOD       1   2953.449446  4491.9523057         0.657        0.5110
     WARE       1  -2207.052539  3118.1407809        -0.708        0.4793
     SCHOOL     1    112.189887  2798.5163795         0.040        0.9680
     CLINIC     1    -48.292864  3476.4069119        -0.014        0.9889
     HOTLMOTL   1  -1390.807518  4034.0019240        -0.345        0.7304
     PERSREP    1   -142.733038  2715.5543056        -0.053        0.9581
     COMSERV    1  -1909.963143  2266.6622951        -0.843        0.3997
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Fifth model specification

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                             The SAS System                               28
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Model: MODEL1
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Dependent Variable: LRATIO

                              Analysis of Variance

                                 Sum of         Mean
        Source          DF      Squares       Square      F Value       Prob>F

        Model           17      2.14475      0.12616        2.636       0.0009
        Error          151      7.22772      0.04787
        C Total        168      9.37247

            Root MSE       0.21878     R-square       0.2288
            Dep Mean      -0.04879     Adj R-sq       0.1420
            C.V.        -448.42062

                              Parameter Estimates

                        Parameter      Standard    T for H0:
      Variable  DF      Estimate         Error   Parameter=0    Prob > |T|

      INTERCEP   1     -0.010490    0.06133739        -0.171        0.8644
      PART2      1     -0.084663    0.06136078        -1.380        0.1697
      DIFHDDMN   1     -0.005276    0.00179937        -2.932        0.0039
      DIFCDDMN   1   0.000037079    0.00129856         0.029        0.9773
      SUMHRS     1      0.005091    0.00363824         1.399        0.1638
      SUMSQF     1   0.000015072    0.00001259         1.197        0.2332
      ANYSR      1      0.182847    0.06203938         2.947        0.0037
      DIFEMPMN   1     -0.000340    0.01109077        -0.031        0.9756
      OFFICE     1     -0.004872    0.03634551        -0.134        0.8935
      REST       1      0.006191    0.06111020         0.101        0.9194
      RETAIL     1     -0.002769    0.05582809        -0.050        0.9605
      FOOD       1     -0.008781    0.08421327        -0.104        0.9171
      WARE       1      0.157530    0.07263400         2.169        0.0317
      SCHOOL     1      0.028012    0.04835133         0.579        0.5632
      CLINIC     1      0.063691    0.06435342         0.990        0.3239
      HOTLMOTL   1      0.025134    0.10309603         0.244        0.8077
      PERSREP    1      0.055808    0.10064774         0.554        0.5801
      COMSERV    1     -0.029915    0.05666276        -0.528        0.5983

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Model: MODEL2
Dependent Variable: DIFKWHMN

                              Analysis of Variance

                                 Sum of         Mean
        Source          DF      Squares       Square      F Value       Prob>F

        Model           17 3060289228.4 180017013.43        0.705       0.7946
        Error          151  38574275257 255458776.54
        C Total        168  41634564485

            Root MSE   15983.07782     R-square       0.0735
            Dep Mean    1028.95556     Adj R-sq      -0.0308
            C.V.        1553.33023

                              Parameter Estimates

                        Parameter      Standard    T for H0:
      Variable  DF      Estimate         Error   Parameter=0    Prob > |T|

      INTERCEP   1    785.228995  4480.9843900         0.175        0.8611
      PART2      1   2632.842796  4482.6933004         0.587        0.5579
      DIFHDDMN   1     60.762458  131.45270725         0.462        0.6446
      DIFCDDMN   1     30.002756   94.86613154         0.316        0.7522
      SUMHRS     1     12.868655  265.79084201         0.048        0.9614
      SUMSQF     1     -2.121034    0.92001342        -2.305        0.0225
      ANYSR      1  -8306.397862  4532.2680990        -1.833        0.0688
      DIFEMPMN   1    409.356376  810.23269837         0.505        0.6141
      OFFICE     1  -1642.405400  2655.2099717        -0.619        0.5371
      REST       1  -1562.385852  4464.3868702        -0.350        0.7269
      RETAIL     1   2227.321258  4078.5044035         0.546        0.5858
      FOOD       1    897.813820  6152.1749067         0.146        0.8842
      WARE       1  -2998.498954  5306.2551220        -0.565        0.5729
      SCHOOL     1   -162.516730  3532.2917252        -0.046        0.9634
      CLINIC     1    175.987016  4701.3199068         0.037        0.9702
      HOTLMOTL   1   1037.603544  7531.6489521         0.138        0.8906
      PERSREP    1  -2543.906137  7352.7901673        -0.346        0.7298
      COMSERV    1    613.335766  4139.4809394         0.148        0.8824

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Model: MODEL1
Dependent Variable: LRATIO

                              Analysis of Variance

                                 Sum of         Mean
        Source          DF      Squares       Square      F Value       Prob>F
```

```
   Model          17      0.57082      0.03358        0.556       0.9238
   Error         722     43.61214      0.06040
   C Total       739     44.18296

       Root MSE       0.24577     R-square       0.0129
       Dep Mean       0.02240     Adj R-sq      -0.0103
       C.V.        1097.26380

                         Parameter Estimates

                    Parameter      Standard    T for H0:
 Variable  DF        Estimate         Error   Parameter=0    Prob > |T|

 INTERCEP   1        0.016412    0.01745139         0.940        0.3473
 PART2      1        0.000385    0.01980665         0.019        0.9845
 DIFHDDMN   1        0.000361    0.00113583         0.318        0.7507
 DIFCDDMN   1        0.000340    0.00086997         0.391        0.6961
 SUMHRS     1        0.002237    0.00299039         0.748        0.4547
 SUMSQF     1     0.000001266    0.00000125         1.010        0.3131
 ANYSR      1       -0.037218    0.06056909        -0.614        0.5391
 DIFEMPMN   1       -0.000884    0.00535438        -0.165        0.8690
 OFFICE     1        0.009798    0.01850651         0.529        0.5967
 REST       1       -0.028059    0.03173701        -0.884        0.3769
 RETAIL     1        0.023902    0.02715972         0.880        0.3791
 FOOD       1       -0.022410    0.06076056        -0.369        0.7124
 WARE       1        0.073769    0.03947910         1.869        0.0621
 SCHOOL     1       -0.032953    0.04306314        -0.765        0.4444
 CLINIC     1       -0.005441    0.04937845        -0.110        0.9123
 HOTLMOTL   1       -0.013295    0.05260712        -0.253        0.8005
 PERSREP    1        0.029827    0.03325999         0.897        0.3701
 COMSERV    1       -0.017522    0.02901189        -0.604        0.5461

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Model: MODEL2
Dependent Variable: DIFKWHMN

                         Analysis of Variance

                            Sum of          Mean
   Source          DF      Squares        Square      F Value       Prob>F

   Model           17  74256398584 4368023446.1        9.188       0.0001
   Error          722 343252599928 475419113.47
   C Total        739 417508998512

       Root MSE   21804.10772     R-square       0.1779
       Dep Mean     948.79954     Adj R-sq       0.1585
       C.V.        2298.07318

                         Parameter Estimates

                    Parameter      Standard    T for H0:
 Variable  DF        Estimate         Error   Parameter=0    Prob > |T|

 INTERCEP   1     1104.825183  1548.2224602         0.714        0.4757
 PART2      1     3819.326353  1757.1717715         2.174        0.0301
 DIFHDDMN   1       38.252424  100.76642400         0.380        0.7043
 DIFCDDMN   1     -150.414601   77.18010091        -1.949        0.0517
 SUMHRS     1       60.193332  265.29613088         0.227        0.8206
 SUMSQF     1       -1.267035    0.11128909       -11.385        0.0001
 ANYSR      1    -5650.046750  5373.4629583        -1.051        0.2934
 DIFEMPMN   1      992.139205  475.02047880         2.089        0.0371
 OFFICE     1     3761.192336  1641.8286641         2.291        0.0223
 REST       1      398.104488  2815.5888410         0.141        0.8876
 RETAIL     1     1963.548866  2409.5090921         0.815        0.4154
 FOOD       1     3380.496942  5390.4496169         0.627        0.5308
 WARE       1    -2474.500973  3502.4381139        -0.707        0.4801
 SCHOOL     1      286.994259  3820.4011830         0.075        0.9401
 CLINIC     1     -227.313959  4380.6717650        -0.052        0.9586
 HOTLMOTL   1    -2231.068003  4667.1072754        -0.478        0.6328
 PERSREP    1     -482.279087  2950.7019055        -0.163        0.8702
 COMSERV    1    -2500.300111  2573.8267052        -0.971        0.3317

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Model: MODEL1
Dependent Variable: LRATIO

                         Analysis of Variance

                            Sum of          Mean
   Source          DF      Squares        Square      F Value       Prob>F

   Model           17      1.05746      0.06220        1.028       0.4245
   Error          860     52.04973      0.06052
   C Total        877     53.10719

       Root MSE       0.24601     R-square       0.0199
```

Dep Mean	0.01010	Adj R-sq	0.0005
C.V.	2435.77485		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	0.012246	0.01642765	0.745	0.4562
PART2	1	-0.028168	0.01767952	-1.593	0.1115
DIFHDDMN	1	-0.001062	0.00099246	-1.070	0.2847
DIFCDDMN	1	0.000044958	0.00074134	0.061	0.9517
SUMHRS	1	0.003278	0.00241632	1.357	0.1752
SUMSQF	1	0.000001537	0.00000125	1.231	0.2186
ANYSR	1	0.038229	0.04392886	0.870	0.3844
DIFEMPMN	1	-0.001245	0.00489335	-0.254	0.7992
OFFICE	1	0.007827	0.01665253	0.470	0.6385
REST	1	-0.010701	0.02917956	-0.367	0.7139
RETAIL	1	0.018224	0.02462671	0.740	0.4595
FOOD	1	-0.036814	0.05196838	-0.708	0.4789
WARE	1	0.074937	0.03615142	2.073	0.0385
SCHOOL	1	-0.023685	0.03253725	-0.728	0.4668
CLINIC	1	0.012051	0.04036864	0.299	0.7654
HOTLMOTL	1	-0.009652	0.04677566	-0.206	0.8366
PERSREP	1	0.028599	0.03157537	0.906	0.3653
COMSERV	1	-0.010706	0.02628523	-0.407	0.6839

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Model: MODEL2
Dependent Variable: DIFKWHMN

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	17	74965048073	4409708710.2	9.876	0.0001
Error	860	383987324430	446496888.87		
C Total	877	458952372503			

Root MSE	21130.47299	R-square	0.1633
Dep Mean	977.56902	Adj R-sq	0.1468
C.V.	2161.53259		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	1117.304235	1410.9923680	0.792	0.4287
PART2	1	3217.664009	1518.5167936	2.119	0.0344
DIFHDDMN	1	33.612209	85.24360253	0.394	0.6935
DIFCDDMN	1	-107.122777	63.67428827	-1.682	0.0929
SUMHRS	1	11.493022	207.54097433	0.055	0.9559
SUMSQF	1	-1.277749	0.10724272	-11.915	0.0001
ANYSR	1	-7652.134276	3773.1074800	-2.028	0.0429
DIFEMPMN	1	902.779438	420.29609282	2.148	0.0320
OFFICE	1	2897.709457	1430.3074530	2.026	0.0431
REST	1	-108.664032	2506.2707360	-0.043	0.9654
RETAIL	1	1595.285427	2115.2202709	0.754	0.4509
FOOD	1	2762.987822	4463.6316598	0.619	0.5361
WARE	1	-2431.125915	3105.0922529	-0.783	0.4339
SCHOOL	1	-318.787799	2794.6668262	-0.114	0.9092
CLINIC	1	240.140306	3467.3148751	0.069	0.9448
HOTLMOTL	1	-1067.868655	4017.6226195	-0.266	0.7905
PERSREP	1	-517.875556	2712.0496460	-0.191	0.8486
COMSERV	1	-1921.309732	2257.6726703	-0.851	0.3950

Sixth model specification

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Model: MODEL1
Dependent Variable: LRATIO

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	16	2.14471	0.13404	2.819	0.0005
Error	152	7.22776	0.04755		
C Total	168	9.37247			

Root MSE	0.21806	R-square	0.2288
Dep Mean	-0.04879	Adj R-sq	0.1477

```
     C.V.       -446.94433

                        Parameter Estimates

                  Parameter      Standard    T for H0:
Variable  DF       Estimate         Error   Parameter=0    Prob > |T|

INTERCEP   1      -0.010249    0.06055052        -0.169        0.8658
PART2      1      -0.084694    0.06114920        -1.385        0.1681
DIFHDDMN   1      -0.005279    0.00179055        -2.948        0.0037
SUMHRS     1       0.005083    0.00361624         1.406        0.1619
SUMSQF     1    0.000015089    0.00001254         1.203        0.2307
ANYSR      1       0.182620    0.06132565         2.978        0.0034
DIFEMPMN   1      -0.000339    0.01105424        -0.031        0.9755
OFFICE     1      -0.004756    0.03600021        -0.132        0.8951
REST       1       0.006271    0.06084380         0.103        0.9180
RETAIL     1      -0.003029    0.05489617        -0.055        0.9561
FOOD       1      -0.008995    0.08360200        -0.108        0.9145
WARE       1       0.157692    0.07217487         2.185        0.0304
SCHOOL     1       0.027952    0.04814658         0.581        0.5624
CLINIC     1       0.063928    0.06360588         1.005        0.3165
HOTLMOTL   1       0.024997    0.10264431         0.244        0.8079
PERSREP    1       0.056123    0.09971340         0.563        0.5744
COMSERV    1      -0.030042    0.05630213        -0.534        0.5944

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Model: MODEL2
Dependent Variable: DIFKWHMN

                        Analysis of Variance

                           Sum of         Mean
  Source          DF      Squares       Square      F Value       Prob>F

  Model           16 3034737473.4 189671092.09        0.747       0.7422
  Error          152  38599827012 253946230.34
  C Total        168  41634564485

     Root MSE   15935.69046     R-square       0.0729
     Dep Mean    1028.95556     Adj R-sq      -0.0247
     C.V.        1548.72484

                        Parameter Estimates

                  Parameter      Standard    T for H0:
Variable  DF       Estimate         Error   Parameter=0    Prob > |T|

INTERCEP   1     980.800155  4424.9525783         0.222        0.8249
PART2      1    2607.770897  4468.7038498         0.584        0.5604
DIFHDDMN   1      58.398055  130.85083856         0.446        0.6560
SUMHRS     1       6.622727  264.27026675         0.025        0.9800
SUMSQF     1      -2.107453    0.91628600        -2.300        0.0228
ANYSR      1   -8490.023418  4481.5979606        -1.894        0.0601
DIFEMPMN   1     409.797033  807.82928891         0.507        0.6127
OFFICE     1   -1548.825104  2630.8482711        -0.589        0.5569
REST       1   -1497.067990  4446.3850776        -0.337        0.7368
RETAIL     1    2016.517852  4011.7403590         0.503        0.6159
FOOD       1     724.404563  6109.5250134         0.119        0.9058
WARE       1   -2867.764131  5274.4447678        -0.544        0.5874
SCHOOL     1    -211.086305  3518.4889195        -0.060        0.9522
CLINIC     1     367.747074  4648.2345889         0.079        0.9370
HOTLMOTL   1     926.267891  7501.1115479         0.123        0.9019
PERSREP    1   -2289.322485  7286.9249896        -0.314        0.7538
COMSERV    1     510.622548  4114.4859630         0.124        0.9014

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Model: MODEL1
Dependent Variable: LRATIO

                        Analysis of Variance

                           Sum of         Mean
  Source          DF      Squares       Square      F Value       Prob>F

  Model           16      0.56160      0.03510        0.582       0.8988
  Error          723     43.62136      0.06033
  C Total        739     44.18296

     Root MSE       0.24563     R-square       0.0127
     Dep Mean       0.02240     Adj R-sq      -0.0091
     C.V.        1096.62065

                        Parameter Estimates

                  Parameter      Standard    T for H0:
Variable  DF       Estimate         Error   Parameter=0    Prob > |T|

INTERCEP   1       0.018039    0.01693722         1.065        0.2872
```

```
      PART2      1      0.000183    0.01978824         0.009        0.9926
      DIFHDDMN   1      0.000340    0.00113389         0.300        0.7644
      SUMHRS     1      0.002277    0.00298684         0.762        0.4461
      SUMSQF     1   0.000001276    0.00000125         1.018        0.3090
      ANYSR      1     -0.036746    0.06052154        -0.607        0.5439
      DIFEMPMN   1     -0.000618    0.00530798        -0.116        0.9073
      OFFICE     1      0.010538    0.01839851         0.573        0.5670
      REST       1     -0.027194    0.03164117        -0.859        0.3904
      RETAIL     1      0.024737    0.02705966         0.914        0.3609
      FOOD       1     -0.022947    0.06070943        -0.378        0.7056
      WARE       1      0.073000    0.03940692         1.852        0.0644
      SCHOOL     1     -0.031517    0.04288081        -0.735        0.4626
      CLINIC     1     -0.003652    0.04913683        -0.074        0.9408
      HOTLMOTL   1     -0.014406    0.05249955        -0.274        0.7839
      PERSREP    1      0.028494    0.03306527         0.862        0.3891
      COMSERV    1     -0.019004    0.02874580        -0.661        0.5087

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Model: MODEL2
Dependent Variable: DIFKWHMN

                        Analysis of Variance

                           Sum of         Mean
        Source          DF      Squares       Square      F Value       Prob>F

        Model           16  72450697144 4528168571.5        9.488       0.0001
        Error          723 345058301368 477259061.37
        C Total        739 417508998512

            Root MSE   21846.25967     R-square       0.1735
            Dep Mean     948.79954     Adj R-sq       0.1552
            C.V.        2302.51584

                        Parameter Estimates

                       Parameter      Standard    T for H0:
      Variable  DF      Estimate         Error   Parameter=0    Prob > |T|

      INTERCEP   1    384.750619  1506.3945486         0.255        0.7985
      PART2      1   3909.067206  1759.9641388         2.221        0.0267
      DIFHDDMN   1     47.547380  100.84807492         0.471        0.6374
      SUMHRS     1     42.289316  265.64958547         0.159        0.8736
      SUMSQF     1     -1.271316    0.11148251       -11.404        0.0001
      ANYSR      1  -5858.904367  5382.7801461        -1.088        0.2768
      DIFEMPMN   1    874.663825  472.09128293         1.853        0.0643
      OFFICE     1   3433.659002  1636.3616498         2.098        0.0362
      REST       1     15.402396  2814.1625341         0.005        0.9956
      RETAIL     1   1594.097084  2406.6837630         0.662        0.5080
      FOOD       1   3617.918267  5399.4910335         0.670        0.5030
      WARE       1  -2134.295390  3504.8477075        -0.609        0.5427
      SCHOOL     1   -348.588233  3813.8145315        -0.091        0.9272
      CLINIC     1  -1019.073393  4370.2248429        -0.233        0.8157
      HOTLMOTL   1  -1739.808581  4669.3043412        -0.373        0.7096
      PERSREP    1    107.391812  2940.8222090         0.037        0.9709
      COMSERV    1  -1844.218491  2556.6488017        -0.721        0.4709

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Model: MODEL1
Dependent Variable: LRATIO

                        Analysis of Variance

                           Sum of         Mean
        Source          DF      Squares       Square      F Value       Prob>F

        Model           16      1.05724      0.06608        1.093       0.3568
        Error          861     52.04995      0.06045
        C Total        877     53.10719

            Root MSE       0.24587     R-square       0.0199
            Dep Mean       0.01010     Adj R-sq       0.0017
            C.V.        2434.36514

                        Parameter Estimates

                       Parameter      Standard    T for H0:
      Variable  DF      Estimate         Error   Parameter=0    Prob > |T|

      INTERCEP   1      0.012458    0.01604341         0.777        0.4377
      PART2      1     -0.028179    0.01766830        -1.595        0.1111
      DIFHDDMN   1     -0.001065    0.00099107        -1.074        0.2829
      SUMHRS     1      0.003278    0.00241492         1.358        0.1750
      SUMSQF     1   0.000001539    0.00000125         1.233        0.2178
      ANYSR      1      0.038173    0.04389379         0.870        0.3847
      DIFEMPMN   1     -0.001216    0.00486602        -0.250        0.8028
      OFFICE     1      0.007936    0.01654595         0.480        0.6316
      REST       1     -0.010581    0.02909571        -0.364        0.7162
```

RETAIL	1	0.018274	0.02459890	0.743	0.4578
FOOD	1	-0.036884	0.05192547	-0.710	0.4777
WARE	1	0.074892	0.03612270	2.073	0.0384
SCHOOL	1	-0.023588	0.03247898	-0.726	0.4679
CLINIC	1	0.012340	0.04006382	0.308	0.7581
HOTLMOTL	1	-0.009781	0.04670016	-0.209	0.8341
PERSREP	1	0.028472	0.03148732	0.904	0.3661
COMSERV	1	-0.010899	0.02607844	-0.418	0.6761

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Model: MODEL2
Dependent Variable: DIFKWHMN

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	16	73701319266	4606332454.1	10.295	0.0001
Error	861	385251053237	447446054.86		
C Total	877	458952372503			

Root MSE	21152.92072	R-square	0.1606
Dep Mean	977.56902	Adj R-sq	0.1450
C.V.	2163.82887		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	613.032523	1380.2520666	0.444	0.6570
PART2	1	3244.591322	1520.0455281	2.135	0.0331
DIFHDDMN	1	39.426172	85.26400542	0.462	0.6439
SUMHRS	1	11.447820	207.76145145	0.055	0.9561
SUMSQF	1	-1.281118	0.10733792	-11.935	0.0001
ANYSR	1	-7519.065907	3776.2857689	-1.991	0.0468
DIFEMPMN	1	832.089825	418.63473454	1.988	0.0472
OFFICE	1	2638.365055	1423.4865266	1.853	0.0642
REST	1	-394.245714	2503.1718544	-0.157	0.8749
RETAIL	1	1477.196975	2116.3011477	0.698	0.4854
FOOD	1	2929.885703	4467.2698202	0.656	0.5121
WARE	1	-2322.634219	3107.7204717	-0.747	0.4550
SCHOOL	1	-550.268663	2794.2429020	-0.197	0.8439
CLINIC	1	-447.673269	3446.7846281	-0.130	0.8967
HOTLMOTL	1	-760.296569	4017.7244461	-0.189	0.8500
PERSREP	1	-214.624834	2708.9275712	-0.079	0.9369
COMSERV	1	-1463.444556	2243.5895981	-0.652	0.5144

Seventh model specification

The SAS System 45
11:18 Sunday, March 3, 1996

Model: MODEL1
Dependent Variable: LRATIO

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	16	1.79036	0.11190	2.243	0.0060
Error	152	7.58212	0.04988		
C Total	168	9.37247			

Root MSE	0.22334	R-square	0.1910
Dep Mean	-0.04879	Adj R-sq	0.1059
C.V.	-457.76938		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-0.014579	0.06206322	-0.235	0.8146
PART2	1	-0.068980	0.06277994	-1.099	0.2736
DIFHDDMN	1	-0.005606	0.00185705	-3.019	0.0030
SUMHRS	1	0.004434	0.00373120	1.188	0.2365
SUMSQF	1	0.000015969	0.00001286	1.242	0.2163
ALLSR	1	0.010110	0.00870251	1.162	0.2472
DIFEMPMN	1	0.003535	0.01122827	0.315	0.7533
OFFICE	1	0.005160	0.03668537	0.141	0.8883
REST	1	0.006386	0.06231744	0.102	0.9185
RETAIL	1	-0.019651	0.05591108	-0.351	0.7257
FOOD	1	-0.020371	0.08558859	-0.238	0.8122
WARE	1	0.153023	0.07398132	2.068	0.0403

SCHOOL	1	0.017200	0.04924824	0.349	0.7274
CLINIC	1	0.087794	0.06490629	1.353	0.1782
HOTLMOTL	1	-0.013671	0.10562029	-0.129	0.8972
PERSREP	1	0.050490	0.10231623	0.493	0.6224
COMSERV	1	0.014119	0.05638118	0.250	0.8026

The SAS System 46
11:18 Sunday, March 3, 1996

Model: MODEL2
Dependent Variable: DIFKWHMN

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	16	2428296479.3	151768529.96	0.588	0.8891
Error	152	39206268006	257935973.72		
C Total	168	41634564485			

Root MSE	16060.38523	R-square	0.0583
Dep Mean	1028.95556	Adj R-sq	-0.0408
C.V.	1560.84342		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	1088.713281	4462.8964341	0.244	0.8076
PART2	1	2132.337841	4514.4353247	0.472	0.6374
DIFHDDMN	1	63.956478	133.53860631	0.479	0.6327
SUMHRS	1	47.747222	268.30661772	0.178	0.8590
SUMSQF	1	-2.124151	0.92488018	-2.297	0.0230
ALLSR	1	-680.407134	625.78751822	-1.087	0.2786
DIFEMPMN	1	245.048737	807.41197172	0.303	0.7619
OFFICE	1	-1962.128230	2638.0040560	-0.744	0.4582
REST	1	-1500.732456	4481.1776397	-0.335	0.7382
RETAIL	1	2673.465368	4020.5031511	0.665	0.5071
FOOD	1	1298.375972	6154.5799346	0.211	0.8332
WARE	1	-2759.394739	5319.9138491	-0.519	0.6047
SCHOOL	1	163.184367	3541.3860082	0.046	0.9633
CLINIC	1	-831.936523	4667.3387599	-0.178	0.8588
HOTLMOTL	1	3038.235321	7595.0370038	0.400	0.6897
PERSREP	1	-2222.380875	7357.4452034	-0.302	0.7630
COMSERV	1	-1666.281110	4054.3073607	-0.411	0.6817

The SAS System 47
11:18 Sunday, March 3, 1996

Model: MODEL1
Dependent Variable: LRATIO

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	16	0.54236	0.03390	0.562	0.9127
Error	723	43.64061	0.06036		
C Total	739	44.18296			

Root MSE	0.24568	R-square	0.0123
Dep Mean	0.02240	Adj R-sq	-0.0096
C.V.	1096.86252		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	0.016979	0.01683847	1.008	0.3136
PART2	1	-0.000499	0.01998579	-0.025	0.9801
DIFHDDMN	1	0.000375	0.00113308	0.331	0.7404
SUMHRS	1	0.002216	0.00298613	0.742	0.4583
SUMSQF	1	0.000001285	0.00000125	1.025	0.3058
ALLSR	1	-0.000925	0.00414899	-0.223	0.8237
DIFEMPMN	1	-0.000736	0.00530514	-0.139	0.8897
OFFICE	1	0.011447	0.01833225	0.624	0.5326
REST	1	-0.026497	0.03163766	-0.838	0.4026
RETAIL	1	0.025929	0.02698345	0.961	0.3369
FOOD	1	-0.021451	0.06066549	-0.354	0.7237
WARE	1	0.073684	0.03943210	1.869	0.0621
SCHOOL	1	-0.030862	0.04301933	-0.717	0.4734
CLINIC	1	-0.005065	0.04908881	-0.103	0.9179
HOTLMOTL	1	-0.023039	0.05072476	-0.454	0.6498
PERSREP	1	0.029795	0.03299257	0.903	0.3668
COMSERV	1	-0.017496	0.02868735	-0.610	0.5421

The SAS System 48
11:18 Sunday, March 3, 1996

Model: MODEL2
Dependent Variable: DIFKWHMN

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	16	81271815952	5079488497	10.922	0.0001
Error	723	336237182560	465058343.79		
C Total	739	417508998512			

Root MSE	21565.21142	R-square	0.1947
Dep Mean	948.79954	Adj R-sq	0.1768
C.V.	2272.89438		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	380.567635	1478.0197254	0.257	0.7969
PART2	1	5137.578807	1754.2798566	2.929	0.0035
DIFHDDMN	1	29.138025	99.45793340	0.293	0.7696
SUMHRS	1	24.477458	262.11161272	0.093	0.9256
SUMSQF	1	-1.272994	0.11004011	-11.568	0.0001
ALLSR	1	-1636.133854	364.18305478	-4.493	0.0001
DIFEMPMN	1	899.375741	465.66562072	1.931	0.0538
OFFICE	1	3322.391601	1609.1378649	2.065	0.0393
REST	1	-406.039577	2777.0384760	-0.146	0.8838
RETAIL	1	1433.637094	2368.5082090	0.605	0.5452
FOOD	1	3570.784767	5324.9949335	0.671	0.5027
WARE	1	-2838.553030	3461.2059365	-0.820	0.4124
SCHOOL	1	951.702139	3776.0791724	0.252	0.8011
CLINIC	1	-622.065511	4308.8365138	-0.144	0.8852
HOTLMOTL	1	-3661.937881	4452.4337999	-0.822	0.4111
PERSREP	1	43.149883	2895.9673376	0.015	0.9881
COMSERV	1	-1269.215842	2518.0704005	-0.504	0.6144

The SAS System 49
11:18 Sunday, March 3, 1996

Model: MODEL1
Dependent Variable: LRATIO

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	16	1.01528	0.06346	1.049	0.4017
Error	861	52.09191	0.06050		
C Total	877	53.10719			

Root MSE	0.24597	R-square	0.0191
Dep Mean	0.01010	Adj R-sq	0.0009
C.V.	2435.34603		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	0.013381	0.01601183	0.836	0.4035
PART2	1	-0.026548	0.01774012	-1.496	0.1349
DIFHDDMN	1	-0.001119	0.00099199	-1.128	0.2597
SUMHRS	1	0.003267	0.00241610	1.352	0.1767
SUMSQF	1	0.000001525	0.00000125	1.222	0.2221
ALLSR	1	0.000941	0.00377023	0.250	0.8030
DIFEMPMN	1	-0.000923	0.00485566	-0.190	0.8493
OFFICE	1	0.007491	0.01654449	0.453	0.6508
REST	1	-0.011137	0.02910953	-0.383	0.7021
RETAIL	1	0.016891	0.02455574	0.688	0.4917
FOOD	1	-0.038785	0.05189692	-0.747	0.4551
WARE	1	0.073820	0.03614979	2.042	0.0415
SCHOOL	1	-0.025318	0.03246064	-0.780	0.4356
CLINIC	1	0.014682	0.03998221	0.367	0.7135
HOTLMOTL	1	-0.003350	0.04612010	-0.073	0.9421
PERSREP	1	0.027241	0.03146727	0.866	0.3869
COMSERV	1	-0.010661	0.02609040	-0.409	0.6829

The SAS System 50
11:18 Sunday, March 3, 1996

Model: MODEL2
Dependent Variable: DIFKWHMN

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F

```
Model          16  81038524759 5064907797.4       11.539       0.0001
Error         861 377913847745 438924329.55
C Total       877 458952372503

    Root MSE   20950.52099     R-square       0.1766
    Dep Mean     977.56902     Adj R-sq       0.1613
    C.V.        2143.12448

                     Parameter Estimates

                Parameter      Standard    T for H0:
Variable  DF     Estimate         Error   Parameter=0    Prob > |T|

INTERCEP   1    507.723791  1363.8053232         0.372        0.7098
PART2      1   3998.049522  1511.0118976         2.646        0.0083
DIFHDDMN   1     17.857657   84.49299998         0.211        0.8327
SUMHRS     1     24.543521  205.79091431         0.119        0.9051
SUMSQF     1     -1.281820    0.10630247       -12.058        0.0001
ALLSR      1  -1463.089095  321.12870326        -4.556        0.0001
DIFEMPMN   1    832.252008  413.58021597         2.012        0.0445
OFFICE     1   2626.207792  1409.1737906         1.864        0.0627
REST       1   -619.236042  2479.3996471        -0.250        0.8028
RETAIL     1   1444.999274  2091.5312557         0.691        0.4898
FOOD       1   3168.970310  4420.3116560         0.717        0.4736
WARE       1  -2808.673380  3079.0525346        -0.912        0.3619
SCHOOL     1    113.078349  2764.8292432         0.041        0.9674
CLINIC     1   -726.081898  3405.4777872        -0.213        0.8312
HOTLMOTL   1  -1954.760722  3928.2713219        -0.498        0.6189
PERSREP    1   -246.318005  2680.2190965        -0.092        0.9268
COMSERV    1  -1341.047520  2222.2456355        -0.603        0.5464
```

Eighth model specification

```
                                 The SAS System                             1
                                                    09:30 Sunday, March 3, 1996

Model: MODEL1
Dependent Variable: DIFKWHMN

                              Analysis of Variance

                                 Sum of         Mean
        Source          DF      Squares       Square      F Value       Prob>F

        Model           16 3034737473.4 189671092.09        0.747       0.7422
        Error          152  38599827012 253946230.34
        C Total        168  41634564485

            Root MSE   15935.69046     R-square       0.0729
            Dep Mean    1028.95556     Adj R-sq      -0.0247
            C.V.        1548.72484

                              Parameter Estimates

                        Parameter      Standard    T for H0:
      Variable  DF       Estimate         Error   Parameter=0    Prob > |T|

      INTERCEP   1     980.800155  4424.9525783         0.222        0.8249
      PART2      1    2607.770897  4468.7038498         0.584        0.5604
      DIFHDDMN   1      58.398055  130.85083856         0.446        0.6560
      SUMHRS     1       6.622727  264.27026675         0.025        0.9800
      SUMSQF     1      -2.107453    0.91628600        -2.300        0.0228
      ANYSR      1   -8490.023418  4481.5979606        -1.894        0.0601
      DIFEMPMN   1     409.797033  807.82928891         0.507        0.6127
      OFFICE     1   -1548.825104  2630.8482711        -0.589        0.5569
      REST       1   -1497.067990  4446.3850776        -0.337        0.7368
      RETAIL     1    2016.517852  4011.7403590         0.503        0.6159
      FOOD       1     724.404563  6109.5250134         0.119        0.9058
      WARE       1   -2867.764131  5274.4447678        -0.544        0.5874
      SCHOOL     1    -211.086305  3518.4889195        -0.060        0.9522
      CLINIC     1     367.747074  4648.2345889         0.079        0.9370
      HOTLMOTL   1     926.267891  7501.1115479         0.123        0.9019
      PERSREP    1   -2289.322485  7286.9249896        -0.314        0.7538
      COMSERV    1     510.622548  4114.4859630         0.124        0.9014
                                 The SAS System                             2
                                                    09:30 Sunday, March 3, 1996

Model: MODEL2
Dependent Variable: DIFKWHMN

                              Analysis of Variance

                                 Sum of         Mean
        Source          DF      Squares       Square      F Value       Prob>F

        Model           17 3684614200.1 216742011.77        0.862       0.6189
        Error          151  37949950285 251324174.07
```

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
C Total	168	41634564485			

Root MSE	15853.20706	R-square	0.0885
Dep Mean	1028.95556	Adj R-sq	-0.0141
C.V.	1540.70862		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-5168.939649	5831.2724479	-0.886	0.3768
PART2	1	15346	9083.5649975	1.689	0.0932
DIFHDDMN	1	63.162744	130.20727057	0.485	0.6283
SUMHRS	1	-79.732071	268.33103676	-0.297	0.7668
SUMSQF	1	-2.659356	0.97401585	-2.730	0.0071
ANYSR	1	-12613	5142.9263853	-2.452	0.0153
DIFEMPMN	1	278.523325	807.78363101	0.345	0.7307
OFFICE	1	-2673.371994	2709.0503291	-0.987	0.3253
REST	1	-907.845564	4438.5213081	-0.205	0.8382
RETAIL	1	931.831037	4047.5778278	0.230	0.8182
FOOD	1	698.572601	6077.9232401	0.115	0.9086
WARE	1	-2377.781018	5255.9840440	-0.452	0.6516
SCHOOL	1	-1741.564260	3627.3671732	-0.480	0.6318
CLINIC	1	68.327020	4627.9226047	0.015	0.9882
HOTLMOTL	1	1740.230621	7479.4336022	0.233	0.8163
PERSREP	1	-1250.725571	7277.9233179	-0.172	0.8638
COMSERV	1	1964.079791	4191.7981768	0.469	0.6401
MILLS	1	-4857.510152	3020.7539830	-1.608	0.1099

The SAS System 3
09:30 Sunday, March 3, 1996

Model: MODEL3
Dependent Variable: DIFKWHMN

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	18	3742864062.9	207936892.38	0.823	0.6709
Error	150	37891700422	252611336.15		
C Total	168	41634564485			

Root MSE	15893.75148	R-square	0.0899
Dep Mean	1028.95556	Adj R-sq	-0.0193
C.V.	1544.64897		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	2153.861679	16331.741942	0.132	0.8953
PART2	1	8438.323265	17024.813758	0.496	0.6209
DIFHDDMN	1	63.705587	130.54516906	0.488	0.6263
SUMHRS	1	-73.902737	269.29104744	-0.274	0.7841
SUMSQF	1	-2.670221	0.97676897	-2.734	0.0070
ANYSR	1	-12924	5196.7920750	-2.487	0.0140
DIFEMPMN	1	344.350492	821.36962169	0.419	0.6756
OFFICE	1	-2604.420975	2719.7716722	-0.958	0.3398
REST	1	-830.073132	4452.8191574	-0.186	0.8524
RETAIL	1	880.528273	4059.3356122	0.217	0.8286
FOOD	1	773.929510	6095.4878703	0.127	0.8991
WARE	1	-2797.943287	5341.5760533	-0.524	0.6012
SCHOOL	1	-1852.794751	3644.0135783	-0.508	0.6119
CLINIC	1	177.653328	4645.3408687	0.038	0.9695
HOTLMOTL	1	1766.594281	7498.7631616	0.236	0.8141
PERSREP	1	-1069.211225	7306.3211108	-0.146	0.8838
COMSERV	1	2106.321797	4212.9450892	0.500	0.6178
MILLS	1	743.678889	12051.054100	0.062	0.9509
MILLS2	1	-5884.282284	12253.847280	-0.480	0.6318

The SAS System 4
09:30 Sunday, March 3, 1996

Model: MODEL1
Dependent Variable: DIFKWHMN

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	16	72450697144	4528168571.5	9.488	0.0001
Error	723	345058301368	477259061.37		
C Total	739	417508998512			

Root MSE	21846.25967	R-square	0.1735
Dep Mean	948.79954	Adj R-sq	0.1552
C.V.	2302.51584		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	384.750619	1506.3945486	0.255	0.7985
PART2	1	3909.067206	1759.9641388	2.221	0.0267
DIFHDDMN	1	47.547380	100.84807492	0.471	0.6374
SUMHRS	1	42.289316	265.64958547	0.159	0.8736
SUMSQF	1	-1.271316	0.11148251	-11.404	0.0001
ANYSR	1	-5858.904367	5382.7801461	-1.088	0.2768
DIFEMPMN	1	874.663825	472.09128293	1.853	0.0643
OFFICE	1	3433.659002	1636.3616498	2.098	0.0362
REST	1	15.402396	2814.1625341	0.005	0.9956
RETAIL	1	1594.097084	2406.6837630	0.662	0.5080
FOOD	1	3617.918267	5399.4910335	0.670	0.5030
WARE	1	-2134.295390	3504.8477075	-0.609	0.5427
SCHOOL	1	-348.588233	3813.8145315	-0.091	0.9272
CLINIC	1	-1019.073393	4370.2248429	-0.233	0.8157
HOTLMOTL	1	-1739.808581	4669.3043412	-0.373	0.7096
PERSREP	1	107.391812	2940.8222090	0.037	0.9709
COMSERV	1	-1844.218491	2556.6488017	-0.721	0.4709

The SAS System 5
09:30 Sunday, March 3, 1996

Model: MODEL2
Dependent Variable: DIFKWHMN

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	17	72917631133	4289272419.6	8.987	0.0001
Error	722	344591367379	477273362.02		
C Total	739	417508998512			

Root MSE	21846.58697	R-square	0.1746
Dep Mean	948.79954	Adj R-sq	0.1552
C.V.	2302.55034		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-2296.043206	3100.8197318	-0.740	0.4593
PART2	1	9095.243324	5530.7829395	1.644	0.1005
DIFHDDMN	1	52.577277	100.97771558	0.521	0.6027
SUMHRS	1	12.514450	267.35368021	0.047	0.9627
SUMSQF	1	-1.285691	0.11242744	-11.436	0.0001
ANYSR	1	-6571.200799	5430.8186461	-1.210	0.2267
DIFEMPMN	1	796.685341	478.63571307	1.664	0.0964
OFFICE	1	3266.045291	1645.1371177	1.985	0.0475
REST	1	134.538206	2816.7810877	0.048	0.9619
RETAIL	1	1656.582016	2407.5487768	0.688	0.4916
FOOD	1	4057.235582	5417.8086279	0.749	0.4542
WARE	1	-1799.690545	3521.1880219	-0.511	0.6094
SCHOOL	1	-859.931753	3848.7503322	-0.223	0.8233
CLINIC	1	-1640.765055	4415.2572187	-0.372	0.7103
HOTLMOTL	1	-1538.802059	4673.7944547	-0.329	0.7421
PERSREP	1	187.214483	2941.9733437	0.064	0.9493
COMSERV	1	-1985.400309	2560.6683939	-0.775	0.4384
MILLS	1	-2104.813501	2127.9894709	-0.989	0.3229

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Model: MODEL3
Dependent Variable: DIFKWHMN

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	18	73289796062	4071655336.8	8.528	0.0001
Error	721	344219202450	477419143.48		
C Total	739	417508998512			

Root MSE	21849.92319	R-square	0.1755
Dep Mean	948.79954	Adj R-sq	0.1550
C.V.	2302.90196		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	845.316560	4719.8548456	0.179	0.8579

PART2	1	7617.888177	5779.1651451	1.318	0.1879
DIFHDDMN	1	58.865066	101.24391995	0.581	0.5611
SUMHRS	1	43.185162	269.64153720	0.160	0.8728
SUMSQF	1	-1.290155	0.11255821	-11.462	0.0001
ANYSR	1	-7013.717611	5454.7229469	-1.286	0.1989
DIFEMPMN	1	845.283973	481.86295853	1.754	0.0798
OFFICE	1	3359.127190	1648.7623982	2.037	0.0420
REST	1	191.291512	2817.9444737	0.068	0.9459
RETAIL	1	1560.954650	2410.3510948	0.648	0.5174
FOOD	1	3786.556636	5427.3017415	0.698	0.4856
WARE	1	-1744.759524	3522.2752640	-0.495	0.6205
SCHOOL	1	-882.016702	3849.4193521	-0.229	0.8188
CLINIC	1	-1354.962820	4427.7799167	-0.306	0.7597
HOTLMOTL	1	-1293.295239	4682.7712762	-0.276	0.7825
PERSREP	1	68.199888	2945.5086610	0.023	0.9815
COMSERV	1	-2131.952816	2566.4327969	-0.831	0.4064
MILLS	1	329.988924	3483.4742816	0.095	0.9246
MILLS2	1	-3761.942360	4260.8311996	-0.883	0.3776

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Model: MODEL1
Dependent Variable: DIFKWHMN

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	16	73701319266	4606332454.1	10.295	0.0001
Error	861	385251053237	447446054.86		
C Total	877	458952372503			

Root MSE	21152.92072	R-square	0.1606
Dep Mean	977.56902	Adj R-sq	0.1450
C.V.	2163.82887		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	613.032523	1380.2520666	0.444	0.6570
PART2	1	3244.591322	1520.0455281	2.135	0.0331
DIFHDDMN	1	39.426172	85.26400542	0.462	0.6439
SUMHRS	1	11.447820	207.76145145	0.055	0.9561
SUMSQF	1	-1.281118	0.10733792	-11.935	0.0001
ANYSR	1	-7519.065907	3776.2857689	-1.991	0.0468
DIFEMPMN	1	832.089825	418.63473454	1.988	0.0472
OFFICE	1	2638.365055	1423.4865266	1.853	0.0642
REST	1	-394.245714	2503.1718544	-0.157	0.8749
RETAIL	1	1477.196975	2116.3011477	0.698	0.4854
FOOD	1	2929.885703	4467.2698202	0.656	0.5121
WARE	1	-2322.634219	3107.7204717	-0.747	0.4550
SCHOOL	1	-550.268663	2794.2429020	-0.197	0.8439
CLINIC	1	-447.673269	3446.7846281	-0.130	0.8967
HOTLMOTL	1	-760.296569	4017.7244461	-0.189	0.8500
PERSREP	1	-214.624834	2708.9275712	-0.079	0.9369
COMSERV	1	-1463.444556	2243.5895981	-0.652	0.5144

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Model: MODEL2
Dependent Variable: DIFKWHMN

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	17	74365000373	4374411786.6	9.782	0.0001
Error	860	384587372130	447194618.76		
C Total	877	458952372503			

Root MSE	21146.97659	R-square	0.1620
Dep Mean	977.56902	Adj R-sq	0.1455
C.V.	2163.22082		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-2115.034764	2630.3520548	-0.804	0.4216
PART2	1	8630.759717	4675.1469173	1.846	0.0652
DIFHDDMN	1	43.716788	85.31277627	0.512	0.6085
SUMHRS	1	-23.151149	209.63581400	-0.110	0.9121
SUMSQF	1	-1.297796	0.10817750	-11.997	0.0001
ANYSR	1	-8692.925978	3896.2539537	-2.231	0.0259
DIFEMPMN	1	756.170238	423.13148180	1.787	0.0743

```
      OFFICE     1   2402.324247  1436.2161066         1.673        0.0948
      REST       1   -236.432394  2505.8191413        -0.094        0.9249
      RETAIL     1   1465.995111  2115.7264327         0.693        0.4886
      FOOD       1   3294.637005  4476.0396946         0.736        0.4619
      WARE       1  -2010.413743  3117.4001083        -0.645        0.5192
      SCHOOL     1  -1162.804438  2838.3479844        -0.410        0.6821
      CLINIC     1   -943.730520  3469.7917043        -0.272        0.7857
      HOTLMOTL   1   -429.996287  4025.7360000        -0.107        0.9150
      PERSREP    1   -120.626732  2709.2653020        -0.045        0.9645
      COMSERV    1  -1494.342774  2243.1025291        -0.666        0.5055
      MILLS      1  -2168.124231  1779.7242591        -1.218        0.2235

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Model: MODEL3
Dependent Variable: DIFKWHMN

                        Analysis of Variance

                              Sum of         Mean
        Source          DF      Squares       Square      F Value       Prob>F

        Model           18  74610838324 4145046573.6        9.264       0.0001
        Error          859 384341534179 447429026.98
        C Total        877 458952372503

            Root MSE   21152.51822     R-square       0.1626
            Dep Mean     977.56902     Adj R-sq       0.1450
            C.V.        2163.78770

                        Parameter Estimates

                     Parameter      Standard    T for H0:
      Variable  DF      Estimate         Error   Parameter=0    Prob > |T|

      INTERCEP   1    560.706760  4466.8727866         0.126        0.9001
      PART2      1   6907.167951  5222.5762036         1.323        0.1863
      DIFHDDMN   1     46.639149   85.42615621         0.546        0.5852
      SUMHRS     1    -11.713453  210.25771490        -0.056        0.9556
      SUMSQF     1     -1.300579    0.10827097       -12.012        0.0001
      ANYSR      1  -9101.256281  3936.0145027        -2.312        0.0210
      DIFEMPMN   1    797.411158  426.88359911         1.868        0.0621
      OFFICE     1   2456.239752  1438.4326542         1.708        0.0881
      REST       1   -188.059366  2507.3252038        -0.075        0.9402
      RETAIL     1   1378.622633  2119.5609483         0.650        0.5156
      FOOD       1   3150.184242  4481.4518525         0.703        0.4823
      WARE       1  -1995.370003  3118.2830787        -0.640        0.5224
      SCHOOL     1  -1274.229725  2843.0685414        -0.448        0.6541
      CLINIC     1   -736.839549  3481.9059424        -0.212        0.8325
      HOTLMOTL   1   -240.662935  4034.8838574        -0.060        0.9525
      PERSREP    1   -184.231176  2711.3334181        -0.068        0.9458
      COMSERV    1  -1523.346648  2244.0315037        -0.679        0.4974
      MILLS      1    -87.518360  3323.8207261        -0.026        0.9790
      MILLS2     1  -2824.406977  3810.3501742        -0.741        0.4587
```

Ninth model specification

```
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Model: MODEL1
Dependent Variable: DIFKWHMN

                        Analysis of Variance

                              Sum of         Mean
        Source          DF      Squares       Square      F Value       Prob>F

        Model           18 3287630819.7 182646156.65        0.714       0.7925
        Error          150  38346933666 255646224.44
        C Total        168  41634564485

            Root MSE   15988.94069     R-square       0.0790
            Dep Mean    1028.95556     Adj R-sq      -0.0316
            C.V.        1553.90002

                        Parameter Estimates

                     Parameter      Standard    T for H0:
      Variable  DF      Estimate         Error   Parameter=0    Prob > |T|

      INTERCEP   1    826.210773  4445.0844295         0.186        0.8528
      PART2      1   2649.005930  4484.2667112         0.591        0.5556
      DIFHDDMN   1     51.864593  133.49391502         0.389        0.6982
      SUMHRS     1     -0.232100  265.28450394        -0.001        0.9993
      SUMSQF     1     -2.189260    0.92335614        -2.371        0.0190
      SUMHU      1   6781.841059  8945.4999492         0.758        0.4496
      SUMHN      1   5452.673211  5574.9672716         0.978        0.3296
```

```
ANYSR      1        -15844  8786.9084208        -1.803        0.0734
DIFEMPMN   1    263.249406  833.79140081         0.316        0.7526
OFFICE     1  -1881.505883  2660.9532025        -0.707        0.4806
REST       1  -1233.238249  4469.2919346        -0.276        0.7830
RETAIL     1   1977.375855  4031.4314438         0.490        0.6245
FOOD       1    556.636155  6132.5263635         0.091        0.9278
WARE       1  -2834.118721  5292.5232808        -0.535        0.5931
SCHOOL     1   -107.273002  3531.8748618        -0.030        0.9758
CLINIC     1    353.545913  4750.5682759         0.074        0.9408
HOTLMOTL   1    921.948867  7530.2379518         0.122        0.9027
PERSREP    1  -2520.336887  7314.9846633        -0.345        0.7309
COMSERV    1   1358.557027  4219.9599912         0.322        0.7479

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Model: MODEL1
Dependent Variable: DIFKWHMN

                       Analysis of Variance

                          Sum of         Mean
   Source          DF      Squares       Square      F Value       Prob>F

   Model           18  85803001053 4766833391.8       10.361       0.0001
   Error          721 331705997459 460063796.75
   C Total        739 417508998512

       Root MSE   21449.09781     R-square       0.2055
       Dep Mean     948.79954     Adj R-sq       0.1857
       C.V.        2260.65643

                       Parameter Estimates

                   Parameter      Standard    T for H0:
Variable  DF        Estimate         Error   Parameter=0    Prob > |T|

INTERCEP   1    112.854390  1479.8971553         0.076        0.9392
PART2      1   4147.820966  1728.5912131         2.400        0.0167
DIFHDDMN   1     30.563089   99.06506149         0.309        0.7578
SUMHRS     1      6.305710  261.13162208         0.024        0.9807
SUMSQF     1     -1.279596    0.10946698       -11.689        0.0001
SUMHU      1        -35375  7903.4936053        -4.476        0.0001
SUMHN      1  -1528.459535  8487.1352567        -0.180        0.8571
ANYSR      1   8458.564011  7186.4467368         1.177        0.2396
DIFEMPMN   1    945.770727  463.80952518         2.039        0.0418
OFFICE     1   3625.432862  1607.3496827         2.256        0.0244
REST       1     44.349958  2763.1653453         0.016        0.9872
RETAIL     1   1839.937472  2363.4689287         0.778        0.4365
FOOD       1   3803.823781  5301.4710275         0.718        0.4733
WARE       1  -1348.103542  3454.4941745        -0.390        0.6965
SCHOOL     1   -415.368038  3744.5005734        -0.111        0.9117
CLINIC     1   -931.403776  4310.5676188        -0.216        0.8290
HOTLMOTL   1  -5352.948926  4648.1872372        -1.152        0.2499
PERSREP    1    367.597721  2887.7840412         0.127        0.8987
COMSERV    1  -1752.247951  2511.0069363        -0.698        0.4855

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Model: MODEL1
Dependent Variable: DIFKWHMN

                       Analysis of Variance

                          Sum of         Mean
   Source          DF      Squares       Square      F Value       Prob>F

   Model           18  88148105912 4897116995.1        6.362       0.0001
   Error          480 369483582592 769757463.73
   C Total        498 457631688505

       Root MSE   27744.50331     R-square       0.1926
       Dep Mean    1913.45808     Adj R-sq       0.1623
       C.V.        1449.96661

                       Parameter Estimates

                   Parameter      Standard    T for H0:
Variable  DF        Estimate         Error   Parameter=0    Prob > |T|

INTERCEP   1   4119.165779  7155.2849587         0.576        0.5651
PART2      1    463.708601  7256.4737517         0.064        0.9491
DIFHDDMN   1     63.582505  138.61368090         0.459        0.6467
SUMHRS     1    -20.790515  362.46991486        -0.057        0.9543
SUMSQF     1     -1.271730    0.14203290        -8.954        0.0001
SUMHU      1        -23647  7000.7411886        -3.378        0.0008
SUMHN      1  -8467.449501  5751.5849400        -1.472        0.1416
ANYSR      1   7665.662733  7213.4196136         1.063        0.2885
DIFEMPMN   1   1823.985634  731.16376627         2.495        0.0129
OFFICE     1   5763.842938  2631.1187631         2.191        0.0290
REST       1  -2450.350903  4779.2704157        -0.513        0.6084
```

RETAIL	1	2582.014775	4425.6898685	0.583	0.5599
FOOD	1	5583.969405	8109.2875405	0.689	0.4914
WARE	1	-2760.162217	5169.2799839	-0.534	0.5936
SCHOOL	1	-1040.397878	4119.4392962	-0.253	0.8007
CLINIC	1	-173.067919	5154.6734444	-0.034	0.9732
HOTLMOTL	1	-2586.367830	5822.5285830	-0.444	0.6571
PERSREP	1	-2182.429757	7653.6750755	-0.285	0.7757
COMSERV	1	-3113.171682	4012.8932275	-0.776	0.4383

APPENDIX G

Discrete Choice NTG Model Specifications and Diagnostics

Appendix G

Discrete Choice NTG Model Specifications and Diagnostics

The purpose of this appendix is to provide further documentation of the analysis which led to the selection of a discrete choice model to use in estimating a program net-to-gross ratio. This appendix is presented in two parts. The first part provides descriptive statistics for the variables that were used in various model specifications. The second part provides model specifications and diagnostics for a series of models which were tested.

G.1 Descriptive Statistics for Model Variables

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PART3	BLDGOCC	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	2	0.5	2	0.5
0	1	8	2.0	10	2.4
0	2	6	1.5	16	3.9
0	3	7	1.7	23	5.6
0	4	3	0.7	26	6.3
1	0	7	1.7	33	8.0
1	1	62	15.1	95	23.2
1	2	171	41.7	266	64.9
1	3	96	23.4	362	88.3
1	4	48	11.7	410	100.0

Frequency Missing = 470

PART3	BLTBEFOR	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	2	0.4	2	0.4
0	1979	19	4.1	21	4.5
0	1984	3	0.6	24	5.2
0	1989	2	0.4	26	5.6
1	0	34	7.3	60	12.9
1	1979	305	65.7	365	78.7
1	1984	33	7.1	398	85.8
1	1989	40	8.6	438	94.4
1	1996	26	5.6	464	100.0

Frequency Missing = 416

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PART3	BTYPE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	2	7	1.5	7	1.5
0	3	3	0.6	10	2.2
0	5	1	0.2	11	2.4

0	6	1	0.2	12	2.6
0	7	1	0.2	13	2.8
0	8	1	0.2	14	3.0
0	9	3	0.6	17	3.7
0	12	2	0.4	19	4.1
0	13	1	0.2	20	4.3
0	14	4	0.9	24	5.2
0	16	2	0.4	26	5.6
1	1	10	2.2	36	7.8
1	2	148	31.9	184	39.7
1	3	22	4.7	206	44.4
1	4	1	0.2	207	44.6
1	5	40	8.6	247	53.2
1	6	9	1.9	256	55.2
1	8	22	4.7	278	59.9
1	9	52	11.2	330	71.1
1	10	12	2.6	342	73.7
1	11	2	0.4	344	74.1
1	12	23	5.0	367	79.1
1	13	18	3.9	385	83.0
1	14	21	4.5	406	87.5
1	15	8	1.7	414	89.2
1	16	50	10.8	464	100.0

Frequency Missing = 416

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PART3	DEPVAR	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	26	5.6	26	5.6
1	1	438	94.4	464	100.0

Frequency Missing = 416

PART3	LOACOOL	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	2	8.0	2	8.0
1	1	23	92.0	25	100.0

Frequency Missing = 855

PART3	LOACOOLE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	1	100.0	1	100.0

Frequency Missing = 879

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PART3	LOADDHTG	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	6	85.7	6	85.7
1	2	1	14.3	7	100.0

Frequency Missing = 873

PART3	LOASD	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	4	100.0	4	100.0

Frequency Missing = 876

PART3	LOELSEHT	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	2	100.0	2	100.0

Frequency Missing = 878

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PART3	LOELSEOT	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	4	50.0	4	50.0
1	22	1	12.5	5	62.5
1	27	1	12.5	6	75.0
1	30	2	25.0	8	100.0

Frequency Missing = 872

PART3	LOEMS	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	18	100.0	18	100.0

Frequency Missing = 862

PART3	LOFIXREP	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	7	9.7	7	9.7
1	1	26	36.1	33	45.8
1	2	1	1.4	34	47.2
1	23	3	4.2	37	51.4
1	24	2	2.8	39	54.2
1	25	15	20.8	54	75.0
1	26	1	1.4	55	76.4
1	27	1	1.4	56	77.8
1	28	1	1.4	57	79.2
1	29	2	2.8	59	81.9
1	30	2	2.8	61	84.7
1	31	2	2.8	63	87.5
1	32	3	4.2	66	91.7
1	33	3	4.2	69	95.8
1	35	3	4.2	72	100.0

Frequency Missing = 808

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PART3	LOHN	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	13	65.0	13	65.0
1	2	5	25.0	18	90.0
1	3	2	10.0	20	100.0

Frequency Missing = 860

PART3	LOHU	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	1	2.2	1	2.2
1	1	39	86.7	40	88.9
1	2	5	11.1	45	100.0

Frequency Missing = 835

PART3	LOLAMPRP	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	1	0.3	1	0.3
0	24	1	0.3	2	0.6
0	26	5	1.5	7	2.0
0	27	1	0.3	8	2.3
0	29	9	2.6	17	4.9
0	31	1	0.3	18	5.2
0	34	1	0.3	19	5.5
0	35	1	0.3	20	5.8
1	1	23	6.7	43	12.5
1	11	1	0.3	44	12.8
1	14	1	0.3	45	13.1
1	19	2	0.6	47	13.7
1	21	3	0.9	50	14.5
1	22	3	0.9	53	15.4

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PART3	LOLAMPRP	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	23	24	7.0	77	22.4
1	24	12	3.5	89	25.9
1	25	38	11.0	127	36.9
1	26	21	6.1	148	43.0
1	27	15	4.4	163	47.4
1	28	25	7.3	188	54.7
1	29	16	4.7	204	59.3
1	30	22	6.4	226	65.7
1	31	23	6.7	249	72.4
1	32	21	6.1	270	78.5
1	33	16	4.7	286	83.1
1	34	15	4.4	301	87.5
1	35	43	12.5	344	100.0

Frequency Missing = 536

PART3	LOLN	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	34	94.4	34	94.4
1	2	2	5.6	36	100.0

Frequency Missing = 844

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PART3	LOLU	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	3	4.5	3	4.5
1	1	46	69.7	49	74.2
1	2	10	15.2	59	89.4
1	3	5	7.6	64	97.0
1	4	2	3.0	66	100.0

Frequency Missing = 814

PART3	LOOT	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	9	81.8	9	81.8
1	2	1	9.1	10	90.9
1	3	1	9.1	11	100.0

Frequency Missing = 869

PART3	OFFICE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	19	4.1	19	4.1
0	1	7	1.5	26	5.6
1	0	280	60.3	306	65.9
1	1	158	34.1	464	100.0

Frequency Missing = 416

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PART3	RESTAU	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	23	5.0	23	5.0
0	1	3	0.6	26	5.6
1	0	416	89.7	442	95.3
1	1	22	4.7	464	100.0

Frequency Missing = 416

PART3	RETAIL	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	25	5.4	25	5.4
0	1	1	0.2	26	5.6
1	0	397	85.6	423	91.2
1	1	41	8.8	464	100.0

Frequency Missing = 416

PART3	FOOD	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	25	5.4	25	5.4
0	1	1	0.2	26	5.6
1	0	429	92.5	455	98.1
1	1	9	1.9	464	100.0

Frequency Missing = 416

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PART3	WAREHSE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	24	5.2	24	5.2
0	1	2	0.4	26	5.6
1	0	416	89.7	442	95.3
1	1	22	4.7	464	100.0

Frequency Missing = 416

PART3	SCHOOL	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	23	5.0	23	5.0
0	1	3	0.6	26	5.6
1	0	374	80.6	400	86.2
1	1	64	13.8	464	100.0

Frequency Missing = 416

Cumulative Cumulative

PART3	HOSPCLIN	Frequency	Percent	Frequency	Percent
0	0	24	5.2	24	5.2
0	1	2	0.4	26	5.6
1	0	413	89.0	439	94.6
1	1	25	5.4	464	100.0

Frequency Missing = 416

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PART3	HOTMOTEL	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	25	5.4	25	5.4
0	1	1	0.2	26	5.6
1	0	420	90.5	446	96.1
1	1	18	3.9	464	100.0

Frequency Missing = 416

PART3	MISC	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	22	4.7	22	4.7
0	1	4	0.9	26	5.6
1	0	409	88.1	435	93.8
1	1	29	6.3	464	100.0

Frequency Missing = 416

PART3	COMSERV	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	24	5.2	24	5.2
0	1	2	0.4	26	5.6
1	0	388	83.6	414	89.2
1	1	50	10.8	464	100.0

Frequency Missing = 416

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PART3	LORCOOL	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	1	20.0	1	20.0
1	1	4	80.0	5	100.0

Frequency Missing = 875

For PART3*LORCOOLE
all data are missing since all
the levels of variable LORCOOLE are missing.

PART3	LOREMLI	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	2	15.4	2	15.4
1	1	11	84.6	13	100.0

Frequency Missing = 867

PART3	LOTIM	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	2	2	6.9	2	6.9
1	1	26	89.7	28	96.6
1	2	1	3.4	29	100.0

Frequency Missing = 851

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PART3	MNGBLDG	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	13	3.1	13	3.1
0	2	5	1.2	18	4.3
0	3	3	0.7	21	5.0
0	4	5	1.2	26	6.2
1	1	302	71.6	328	77.7
1	2	30	7.1	358	84.8
1	3	53	12.6	411	97.4
1	4	11	2.6	422	100.0

Frequency Missing = 458

PART3	OWN	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	14	3.1	14	3.1
0	2	10	2.2	24	5.2
0	4	1	0.2	25	5.4
1	1	276	60.1	301	65.6
1	2	121	26.4	422	91.9
1	3	37	8.1	459	100.0

Frequency Missing = 421

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PART3	PARTFNL	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	26	5.6	26	5.6
1	1	438	94.4	464	100.0

Frequency Missing = 416

PART3	RESPPAYS	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	2	0.4	2	0.4
0	1	24	5.2	26	5.6
1	0	32	6.9	58	12.5
1	1	406	87.5	464	100.0

Frequency Missing = 416

PART3	SEPMET2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	10	2.2	10	2.2
0	1	16	3.4	26	5.6
1	0	94	20.3	120	25.9
1	1	344	74.1	464	100.0

Frequency Missing = 416

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DEPVAR	BLDGOCC	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	8	1.0	8	1.0
0	1	104	12.8	112	13.8
0	2	177	21.8	289	35.6
0	3	38	4.7	327	40.3
0	4	75	9.2	402	49.5
1	0	9	1.1	411	50.6
1	1	70	8.6	481	59.2
1	2	177	21.8	658	81.0
1	3	103	12.7	761	93.7
1	4	51	6.3	812	100.0

Frequency Missing = 68

DEPVAR	BLTBEFOR	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	44	5.0	44	5.0
0	1979	221	25.1	265	30.1
0	1984	43	4.9	308	35.0
0	1989	56	6.4	364	41.4
0	1996	52	5.9	416	47.3
1	0	36	4.1	452	51.4
1	1979	324	36.8	776	88.2
1	1984	36	4.1	812	92.3
1	1989	42	4.8	854	97.0
1	1996	26	3.0	880	100.0

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DEPVAR	BTYPE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	5	0.6	5	0.6
0	2	108	12.3	113	12.8
0	3	61	6.9	174	19.8
0	5	64	7.3	238	27.0
0	6	33	3.8	271	30.8
0	7	1	0.1	272	30.9
0	8	16	1.8	288	32.7
0	9	15	1.7	303	34.4
0	10	1	0.1	304	34.5
0	11	2	0.2	306	34.8
0	12	17	1.9	323	36.7
0	13	9	1.0	332	37.7
0	14	23	2.6	355	40.3
0	15	22	2.5	377	42.8
0	16	39	4.4	416	47.3
1	1	10	1.1	426	48.4
1	2	155	17.6	581	66.0
1	3	25	2.8	606	68.9
1	4	1	0.1	607	69.0
1	5	41	4.7	648	73.6
1	6	10	1.1	658	74.8
1	7	1	0.1	659	74.9
1	8	23	2.6	682	77.5
1	9	55	6.3	737	83.8
1	10	12	1.4	749	85.1
1	11	2	0.2	751	85.3
1	12	25	2.8	776	88.2
1	13	19	2.2	795	90.3
1	14	25	2.8	820	93.2
1	15	8	0.9	828	94.1
1	16	52	5.9	880	100.0

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DEPVAR	DEPVAR	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	416	47.3	416	47.3
1	1	464	52.7	880	100.0

DEPVAR	LOACOOL	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	21	44.7	21	44.7
0	3	1	2.1	22	46.8
1	1	25	53.2	47	100.0

Frequency Missing = 833

DEPVAR	LOACOOLE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	1	100.0	1	100.0

Frequency Missing = 879

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DEPVAR	LOADDHTG	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	8	50.0	8	50.0
0	3	1	6.3	9	56.3
1	1	6	37.5	15	93.8
1	2	1	6.3	16	100.0

Frequency Missing = 864

DEPVAR	LOASD	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	4	100.0	4	100.0

Frequency Missing = 876

DEPVAR	LOELSEHT	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	3	50.0	3	50.0
0	29	1	16.7	4	66.7
1	1	2	33.3	6	100.0

Frequency Missing = 874

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DEPVAR	LOELSEOT	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	13	52.0	13	52.0
0	29	4	16.0	17	68.0
1	1	4	16.0	21	84.0
1	22	1	4.0	22	88.0
1	27	1	4.0	23	92.0
1	30	2	8.0	25	100.0

Frequency Missing = 855

DEPVAR	OFFICE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	303	34.4	303	34.4
0	1	113	12.8	416	47.3
1	0	299	34.0	715	81.3
1	1	165	18.8	880	100.0

DEPVAR	RESTAU	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	355	40.3	355	40.3
0	1	61	6.9	416	47.3
1	0	439	49.9	855	97.2
1	1	25	2.8	880	100.0

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DEPVAR	RETAIL	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	352	40.0	352	40.0
0	1	64	7.3	416	47.3
1	0	422	48.0	838	95.2
1	1	42	4.8	880	100.0

DEPVAR	FOOD	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	383	43.5	383	43.5
0	1	33	3.8	416	47.3
1	0	454	51.6	870	98.9
1	1	10	1.1	880	100.0

DEPVAR	WAREHSE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	399	45.3	399	45.3
0	1	17	1.9	416	47.3
1	0	440	50.0	856	97.3
1	1	24	2.7	880	100.0

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DEPVAR	SCHOOL	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	400	45.5	400	45.5
0	1	16	1.8	416	47.3
1	0	397	45.1	813	92.4
1	1	67	7.6	880	100.0

DEPVAR	HOSPCLIN	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	397	45.1	397	45.1
0	1	19	2.2	416	47.3
1	0	437	49.7	853	96.9
1	1	27	3.1	880	100.0

DEPVAR	HOTMOTEL	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	407	46.3	407	46.3
0	1	9	1.0	416	47.3
1	0	445	50.6	861	97.8
1	1	19	2.2	880	100.0

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DEPVAR	MISC	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	371	42.2	371	42.2
0	1	45	5.1	416	47.3
1	0	431	49.0	847	96.3
1	1	33	3.8	880	100.0

DEPVAR	COMSERV	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	377	42.8	377	42.8
0	1	39	4.4	416	47.3
1	0	412	46.8	828	94.1
1	1	52	5.9	880	100.0

DEPVAR	LOEMS	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	7	28.0	7	28.0
1	1	18	72.0	25	100.0

Frequency Missing = 855

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DEPVAR	LOFIXREP	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	37	27.4	37	27.4
0	29	26	19.3	63	46.7
1	1	33	24.4	96	71.1
1	2	1	0.7	97	71.9
1	23	3	2.2	100	74.1
1	24	2	1.5	102	75.6
1	25	15	11.1	117	86.7
1	26	1	0.7	118	87.4
1	27	1	0.7	119	88.1
1	28	1	0.7	120	88.9
1	29	2	1.5	122	90.4
1	30	2	1.5	124	91.9
1	31	2	1.5	126	93.3
1	32	3	2.2	129	95.6
1	33	3	2.2	132	97.8
1	35	3	2.2	135	100.0

Frequency Missing = 745

DEPVAR	LOHN	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	1	4.8	1	4.8
1	1	13	61.9	14	66.7
1	2	5	23.8	19	90.5
1	3	2	9.5	21	100.0

Frequency Missing = 859

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DEPVAR	LOHU	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	13	21.7	13	21.7
0	2	2	3.3	15	25.0
1	1	40	66.7	55	91.7
1	2	5	8.3	60	100.0

Frequency Missing = 820

DEPVAR	LOLAMPRP	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	17	2.5	17	2.5
0	29	315	46.6	332	49.1
1	1	24	3.6	356	52.7
1	11	1	0.1	357	52.8
1	14	1	0.1	358	53.0
1	19	2	0.3	360	53.3
1	21	3	0.4	363	53.7
1	22	3	0.4	366	54.1
1	23	24	3.6	390	57.7
1	24	13	1.9	403	59.6
1	25	38	5.6	441	65.2
1	26	26	3.8	467	69.1
1	27	16	2.4	483	71.4
1	28	25	3.7	508	75.1
1	29	25	3.7	533	78.8
1	30	22	3.3	555	82.1
1	31	24	3.6	579	85.7
1	32	21	3.1	600	88.8
1	33	16	2.4	616	91.1
1	34	16	2.4	632	93.5
1	35	44	6.5	676	100.0

Frequency Missing = 204

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DEPVAR	LOLN	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	3	7.5	3	7.5
0	2	1	2.5	4	10.0
1	1	34	85.0	38	95.0
1	2	2	5.0	40	100.0

Frequency Missing = 840

DEPVAR	LOLU	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	14	16.7	14	16.7
0	2	4	4.8	18	21.4
1	1	49	58.3	67	79.8
1	2	10	11.9	77	91.7
1	3	5	6.0	82	97.6
1	4	2	2.4	84	100.0

Frequency Missing = 796

DEPVAR	LOOT	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	5	29.4	5	29.4
0	2	1	5.9	6	35.3

1	1	9	52.9	15	88.2
1	2	1	5.9	16	94.1
1	3	1	5.9	17	100.0

Frequency Missing = 863

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DEPVAR	LORCOOL	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	35	85.4	35	85.4
0	2	1	2.4	36	87.8
1	1	5	12.2	41	100.0

Frequency Missing = 839

For DEPVAR*LORCOOLE
all data are missing since all
the levels of variable LORCOOLE are missing.

DEPVAR	LOREMLI	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	5	27.8	5	27.8
1	1	13	72.2	18	100.0

Frequency Missing = 862

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DEPVAR	LOTIM	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	12	29.3	12	29.3
1	1	26	63.4	38	92.7
1	2	3	7.3	41	100.0

Frequency Missing = 839

DEPVAR	MNGBLDG	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	204	25.2	204	25.2
0	2	82	10.1	286	35.3
0	3	64	7.9	350	43.2
0	4	38	4.7	388	47.9
1	1	315	38.9	703	86.8
1	2	35	4.3	738	91.1
1	3	56	6.9	794	98.0
1	4	16	2.0	810	100.0

Frequency Missing = 70

DEPVAR	OWN	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	193	22.6	193	22.6
0	2	188	22.0	381	44.7
0	3	8	0.9	389	45.6
0	4	5	0.6	394	46.2
1	1	290	34.0	684	80.2
1	2	131	15.4	815	95.5
1	3	37	4.3	852	99.9

1	4	1	0.1	853	100.0

Frequency Missing = 27

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DEPVAR	PARTFNL	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	416	47.3	416	47.3
1	0	26	3.0	442	50.2
1	1	438	49.8	880	100.0

DEPVAR	RESPPAYS	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	34	3.9	34	3.9
0	1	382	43.4	416	47.3
1	0	34	3.9	450	51.1
1	1	430	48.9	880	100.0

DEPVAR	SEPMET2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	0	86	9.8	86	9.8
0	1	330	37.5	416	47.3
1	0	104	11.8	520	59.1
1	1	360	40.9	880	100.0

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--- PART3=. ---

Variable	Label	N	Mean	Std Dev	Minimum	Maximum
COOLSF	conditioned square footage	416	28183.68	57885.66	0	500000.00
GLASPCT2	percent of wall that is glass	381	24.6981627	19.2538642	0	100.0000000
KWHPRE	mean monthly kwh in pre	416	45340.29	160731.17	168.7088274	1817949.22
PREAGG	aggr kwh for all com prems in pre	415	59497.14	77684.11	1154.60	284466.32
PREEFIR	employ in finance in pre	416	23.1894715	30.9904007	0	100.9540250
PREESV	employ in services in pre	416	94.8727989	108.4469497	0	305.9040966
PREET	employ in trade in pre	416	73.9387566	74.2740727	0	204.2067091
PREHDD	pre mean monthly HDD	416	110.7302260	22.6208786	74.7333333	202.1034483
PRESLTR	retail sales in pre	416	166.7950432	72.5178645	0	199.9363857
PRETOTEM	total comm employ in pre	416	192.0010270	210.7422529	0	600.4699303
PREYPNR	real personal income in pre	416	14.5830291	7.5110780	0	25.9931243
SKWHDELT	change in kwh from pre 12 to post	416	903.5224572	15913.67	-23972.21	312610.57
SKWHPRE	pre kwh in pre 12	416	44988.17	155901.89	139.7424242	1784666.55
LOCHGHRS	change in hours in pre	416	-0.0649038	4.4073453	-55.0000000	51.0000000
LOCHGSQF	change in square footage in pre	416	86.2788462	870.5081519	-2000.00	11000.00
WEEKHRS	business hours at time of survey	416	78.4483171	42.8973877	0	168.0000000
PRECDD	mean cdd in pre period	416	70.4638328	58.1294689	1.0344828	270.5862069

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Variable	Label	N	Mean	Std Dev	Minimum	Maximum
COOLSF	conditioned square footage	26	39556.97	54099.97	0	180000.00
GLASPCT2	percent of wall that is glass	22	25.4545455	19.7308733	0	63.0000000
KWHPRE	mean monthly kwh in pre	26	43281.10	70532.99	223.1327677	271194.90
PREAGG	aggr kwh for all com prems in pre	26	71438.03	83634.55	7202.07	284466.32
PREEFIR	employ in finance in pre	26	19.8813841	29.3901425	0	100.9534303
PREESV	employ in services in pre	26	74.7709537	96.5099812	0	305.8142000
PREET	employ in trade in pre	26	63.7318250	69.7435473	0	204.1829806
PREHDD	pre mean monthly HDD	26	114.7236048	29.1469475	76.2413793	195.3666667
PRESLTR	retail sales in pre	26	183.0092412	53.8791530	0	199.6034235
PRETOTEM	total comm employ in pre	26	158.3841628	193.9577773	0	600.4699303

PREYPNR	real personal income in pre	26	14.5658249	5.7908955	0	25.9931243
SKWHDELT	change in kwh from pre 12 to post	26	2886.29	8078.74	-3214.25	34452.04
SKWHPRE	pre kwh in pre 12	26	43354.17	73560.01	202.3524392	312450.91
LOCHGHRS	change in hours in pre	26	-1.1538462	5.8834841	-30.0000000	0
LOCHGSQF	change in square footage in pre	26	253.8461538	1017.54	0	5000.00
WEEKHRS	business hours at time of survey	26	85.7884615	50.9240951	0	168.0000000
PRECDD	mean cdd in pre period	26	78.0615225	65.7085006	0.0689655	223.4242424

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-- PART3=1 --

Variable	Label	N	Mean	Std Dev	Minimum	Maximum
COOLSF	conditioned square footage	438	50061.15	88419.89	130.0000000	800000.00
GLASPCT2	percent of wall that is glass	385	29.8103896	21.2295955	0	100.0000000
KWHPRE	mean monthly kwh in pre	438	171900.97	873902.45	240.5480598	15350558.81
PREAGG	aggr kwh for all com prems in pre	438	64252.87	81090.49	298.0121877	294971.15
PREEFIR	employ in finance in pre	438	20.1575913	28.3673286	0	100.9613731
PREESV	employ in services in pre	438	86.3449071	104.1388106	0	306.0648343
PREET	employ in trade in pre	438	69.0383745	74.6194221	0	204.7474636
PREHDD	pre mean monthly HDD	438	105.3857117	22.4323445	59.1818182	209.1481481
PRESLTR	retail sales in pre	438	158.5154841	79.5794994	0	201.6545429
PRETOTEM	total comm employ in pre	438	175.5408728	204.3897698	0	600.4699303
PREYPNR	real personal income in pre	438	13.4629360	7.7510936	0	25.9931243
SKWHDELT	change in kwh from pre 12 to post	438	8816.75	145703.11	-327114.93	2930832.51
SKWHPRE	pre kwh in pre 12	438	170567.91	870188.96	191.5011363	15374460.60
LOCHGHRS	change in hours in pre	438	0.0844749	6.5923946	-80.0000000	60.0000000
LOCHGSQF	change in square footage in pre	438	2072.33	19279.17	-7000.00	340000.00
WEEKHRS	business hours at time of survey	438	76.9851598	43.7876096	4.0000000	168.0000000
PRECDD	mean cdd in pre period	438	90.7553944	66.6406610	1.0322581	310.1739130

---------------------------------- installation of efficient equipment=0 ---------------------------------

Variable	Label	N	Mean	Std Dev	Minimum	Maximum
COOLSF	conditioned square footage	416	28183.68	57885.66	0	500000.00
GLASPCT2	percent of wall that is glass	381	24.6981627	19.2538642	0	100.0000000
KWHPRE	mean monthly kwh in pre	416	45340.29	160731.17	168.7088274	1817949.22
PREAGG	aggr kwh for all com prems in pre	415	59497.14	77684.11	1154.60	284466.32
PREEFIR	employ in finance in pre	416	23.1894715	30.9904007	0	100.9540250
PREESV	employ in services in pre	416	94.8727989	108.4469497	0	305.9040966
PREET	employ in trade in pre	416	73.9387566	74.2740727	0	204.2067091
PREHDD	pre mean monthly HDD	416	110.7302260	22.6208786	74.7333333	202.1034483
PRESLTR	retail sales in pre	416	166.7950432	72.5178645	0	199.9363857
PRETOTEM	total comm employ in pre	416	192.0010270	210.7422529	0	600.4699303
PREYPNR	real personal income in pre	416	14.5830291	7.5110780	0	25.9931243
SKWHDELT	change in kwh from pre 12 to post	416	903.5224572	15913.67	-23972.21	312610.57
SKWHPRE	pre kwh in pre 12	416	44988.17	155901.89	139.7424242	1784666.55
LOCHGHRS	change in hours in pre	416	-0.0649038	4.4073453	-55.0000000	51.0000000
LOCHGSQF	change in square footage in pre	416	86.2788462	870.5081519	-2000.00	11000.00
WEEKHRS	business hours at time of survey	416	78.4483171	42.8973877	0	168.0000000
PRECDD	mean cdd in pre period	416	70.4638328	58.1294689	1.0344828	270.5862069

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---------------------------------- installation of efficient equipment=1 ---------------------------------

Variable	Label	N	Mean	Std Dev	Minimum	Maximum
COOLSF	conditioned square footage	464	49472.56	86850.06	0	800000.00
GLASPCT2	percent of wall that is glass	407	29.5749386	21.1514283	0	100.0000000
KWHPRE	mean monthly kwh in pre	464	164693.82	849685.10	223.1327677	15350558.81
PREAGG	aggr kwh for all com prems in pre	464	64655.49	81159.28	298.0121877	294971.15
PREEFIR	employ in finance in pre	464	20.1421141	28.3929772	0	100.9613731
PREESV	employ in services in pre	464	85.6963666	103.6625180	0	306.0648343
PREET	employ in trade in pre	464	68.7410247	74.2934552	0	204.7474636
PREHDD	pre mean monthly HDD	464	105.9089557	22.9226083	59.1818182	209.1481481
PRESLTR	retail sales in pre	464	159.8879791	78.5227325	0	201.6545429
PRETOTEM	total comm employ in pre	464	174.5795055	203.6569957	0	600.4699303
PREYPNR	real personal income in pre	464	13.5247358	7.6538130	0	25.9931243
SKWHDELT	change in kwh from pre 12 to post	464	8484.44	141572.02	-327114.93	2930832.51
SKWHPRE	pre kwh in pre 12	464	163439.55	846082.91	191.5011363	15374460.60
LOCHGHRS	change in hours in pre	464	0.0150862	6.5551151	-80.0000000	60.0000000
LOCHGSQF	change in square footage in pre	464	1970.43	18736.21	-7000.00	340000.00
WEEKHRS	business hours at time of survey	464	77.4784483	44.2020117	0	168.0000000
PRECDD	mean cdd in pre period	464	90.0440998	66.5827757	0.0689655	310.1739130

G.2 Model Specifications and Diagnostics

Shown below are the model specifications and diagnostics for a series of models which were tested.

Alternative Specification 1

Participation Model

Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
c	1.513	0.411	3.681
sepmet2	0.967	0.432	2.241
mngbldg	0.694	0.411	1.689
inprog	1.172	0.635	1.845

Auxiliary Statistics	At Convergence	Initial
log likelihood	-94.453	-321.62
number of observations	464	
percent correctly predicted	94.397	

Implementation Model

Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
c	-1.115	0.247	-4.513
ls	2.426	1.244	1.950
bltbefor	-0.784	0.170	-4.617
glaspct2	0.009	0.004	2.360
precdd	0.005	0.001	3.987
office	0.855	0.180	4.743
inprog	1.039	0.311	3.345
outprog	-0.226	0.089	-2.531
school	1.793	0.318	5.642
warehse	1.223	0.355	3.444
hotmotel	1.576	0.454	3.474
comserv	0.896	0.257	3.487

Auxiliary Statistics	At Convergence	Initial
log likelihood	-521.33	-609.97
number of observations	880	
percent correctly predicted	68.864	

NTG Ratio 1.76

Alternative Specification 2

Participation Model

Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
c	1.513	0.411	3.681
sepmet2	0.967	0.432	2.241
mngbldg	0.694	0.411	1.689
inprog	1.172	0.635	1.845

Auxiliary Statistics	At Convergence	Initial
log likelihood	-94.453	-321.62
number of observations	464	
percent correctly predicted	94.397	

Implementation Model

Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
c	-1.108	0.248	-4.474
ls	0.067	1.602	0.042
bltbefor	-0.758	0.171	-4.443
glaspct2	0.009	0.004	2.404
precdd	0.005	0.001	3.844
office	0.824	0.182	4.539
inprog	1.418	0.360	3.936
outprog	-0.224	0.090	-2.499
school	1.723	0.319	5.394
warehse	1.198	0.358	3.348
hotmotel	1.507	0.456	3.306
comserv	0.811	0.260	3.120
mngbldg	0.471	0.201	2.344

Auxiliary Statistics	At Convergence	Initial
log likelihood	-518.55	-609.97
number of observations	880	
percent correctly predicted	68.295	
NTG Ratio	0.056	

Alternative Specification 3

Participation Model

Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
c	1.513	0.411	3.681
sepmet2	0.967	0.432	2.241
mngbldg	0.694	0.411	1.689
inprog	1.172	0.635	1.845

Auxiliary Statistics	At Convergence	Initial
log likelihood	-94.453	-321.62
number of observations	464	
percent correctly predicted	94.397	

Implementation Model

Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
c	-1.116	0.348	-3.210
ls	0.063	1.606	0.039
bltbefor	-0.758	0.171	-4.443
glaspct2	0.009	0.004	2.404
precdd	0.005	0.001	3.844
office	0.825	0.183	4.513
inprog	1.418	0.361	3.929
outprog	-0.224	0.090	-2.499
school	1.723	0.319	5.394
warehse	1.197	0.358	3.344
hotmotel	1.508	0.457	3.303
comserv	0.810	0.260	3.118
mngbldg	0.470	0.202	2.331
resppays	0.009	0.282	0.032

Auxiliary Statistics	At Convergence	Initial
log likelihood	-518.55	-609.97
number of observations	880	
percent correctly predicted	68.295	

NTG Ratio 0.057

Alternative Specification 4

Participation Model

Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
c	1.513	0.411	3.681
sepmet2	0.967	0.432	2.241
mngbldg	0.694	0.411	1.689
inprog	1.172	0.635	1.845

Auxiliary Statistics	At Convergence	Initial
log likelihood	-94.453	-321.62
number of observations	464	
percent correctly predicted	94.397	

Implementation Model

Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
c	-1.13	0.25	-4.53
ls	0.13	1.61	0.08
bltbefor	-0.75	0.17	-4.41
glaspct2	0.01	0.00	2.34
precdd	0.01	0.00	3.90
office	0.83	0.18	4.55
inprog	1.34	0.37	3.64
outprog	-0.22	0.09	-2.47
school	1.72	0.32	5.38
warehse	1.22	0.36	3.42
hotmotel	1.48	0.46	3.23
comserv	0.83	0.26	3.17
mngbldg	0.45	0.20	2.21
kwhpre	0.00	0.00	1.11

Auxiliary Statistics	At Convergence	Initial
log likelihood	-516.82	-609.97
number of observations	880	
percent correctly predicted	68.068	

NTG Ratio	0.12

Alternative Specification 5

Participation Model

Independent Variable	**Estimated Coefficient**	**Standard Error**	**t-Statistic**
c	1.513	0.411	3.681
sepmet2	0.967	0.432	2.241
mngbldg	0.694	0.411	1.689
inprog	1.172	0.635	1.845

Auxiliary Statistics	**At Convergence**	**Initial**
log likelihood	-94.453	-321.62
number of observations	464	
percent correctly predicted	94.397	

Implementation Model

Independent Variable	**Estimated Coefficient**	**Standard Error**	**t-Statistic**
c	-0.932	0.258	-3.616
ls	-0.326	1.615	-0.202
bltbefor	-0.759	0.171	-4.439
glaspct2	0.009	0.004	2.256
precdd	0.005	0.001	3.693
office	0.797	0.188	4.248
inprog	1.507	0.365	4.132
outprog	-0.235	0.090	-2.605
school	1.764	0.331	5.327
warehse	1.126	0.362	3.107
hotmotel	1.542	0.469	3.292
comserv	0.826	0.272	3.035
mngbldg	0.638	0.221	2.885
food	-0.666	0.402	-1.656
own	-0.283	0.182	-1.551

Auxiliary Statistics	**At Convergence**	**Initial**
log likelihood	-515.78	-609.97
number of observations	880	
percent correctly predicted	67.727	

NTG Ratio -0.3

Alternative Specification 6

Participation Model

Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
c	1.513	0.411	3.681
sepmet2	0.967	0.432	2.241
mngbldg	0.694	0.411	1.689
inprog	1.172	0.635	1.845

Auxiliary Statistics	At Convergence	Initial
log likelihood	-94.453	-321.62
number of observations	464	
percent correctly predicted	94.397	

Implementation Model

Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
c	-1.029	0.256	-4.013
ls	-0.019	1.618	-0.012
bltbefor	-0.757	0.171	-4.428
glaspct2	0.009	0.004	2.258
precdd	0.005	0.001	3.696
office	0.759	0.186	4.084
inprog	1.355	0.370	3.665
outprog	-0.226	0.091	-2.487
school	1.646	0.322	5.106
warehse	1.137	0.361	3.151
hotmotel	1.387	0.461	3.010
comserv	0.742	0.264	2.806
mngbldg	0.475	0.203	2.338
food	-0.677	0.402	-1.685
skwhpre	0.000	0.000	1.119

Auxiliary Statistics	At Convergence	Initial
log likelihood	-515.23	-609.97
number of observations	880	
percent correctly predicted	68.523	

NTG Ratio -1.69

Alternative Specification 7

Participation Model

Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
c	1.891	0.357	5.302
sepmet2	0.999	0.428	2.332
inprog	1.235	0.632	1.954

Auxiliary Statistics	At Convergence	Initial
log likelihood	-95.861	-321.62
number of observations	464	
percent correctly predicted	94.397	

Implementation Model

Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
c	-1.003	0.292	-3.439
ls	-0.097	1.753	-0.055
bltbefor	-0.761	0.171	-4.463
glaspct2	0.009	0.004	2.333
precdd	0.005	0.001	3.644
office	0.756	0.185	4.075
inprog	1.441	0.384	3.754
outprog	-0.227	0.090	-2.515
school	1.650	0.322	5.125
warehse	1.112	0.361	3.083
hotmotel	1.422	0.458	3.103
comserv	0.728	0.264	2.758
mngbldg	0.495	0.157	3.158
food	-0.685	0.403	-1.701

Auxiliary Statistics	At Convergence	Initial
log likelihood	-517	-609.97
number of observations	880	
percent correctly predicted	68.523	

NTG Ratio -0.09

Alternative Specification 8

Participation Model

Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
c	1.813	0.389	4.659
sepmet2	0.788	0.422	1.866
mngbldg	0.762	0.408	1.869

Auxiliary Statistics	At Convergence	Initial
log likelihood	-96.662	-321.62
number of observations	464	
percent correctly predicted	94.397	

Implementation Model

Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
c	-1.045	0.306	-3.419
ls	0.409	2.488	0.165
bltbefor	-0.762	0.171	-4.464
glaspct2	0.009	0.004	2.335
precdd	0.005	0.001	3.635
office	0.761	0.185	4.116
inprog	1.428	0.229	6.246
outprog	-0.227	0.090	-2.514
school	1.652	0.322	5.133
warehse	1.113	0.361	3.085
hotmotel	1.427	0.459	3.110
comserv	0.732	0.264	2.772
mngbldg	0.460	0.261	1.761
food	-0.680	0.402	-1.691

Auxiliary Statistics	At Convergence	Initial
log likelihood	-516.98	-609.97
number of observations	880	
percent correctly predicted	68.523	

NTG Ratio 0.36

Alternative Specification 9

Participation Model

Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
c	2.241	0.333	6.736
sepmet2	0.827	0.420	1.972

Auxiliary Statistics	At Convergence	Initial
log likelihood	-98.376	-321.62
number of observations	464	
percent correctly predicted	94.397	

Implementation Model

Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
c	-1.117	0.386	-2.892
ls	0.862	2.543	0.339
bltbefor	-0.762	0.171	-4.465
glaspct2	0.009	0.004	2.334
precdd	0.005	0.001	3.621
office	0.766	0.185	4.134
inprog	1.434	0.229	6.250
outprog	-0.227	0.090	-2.517
school	1.656	0.322	5.139
warehse	1.113	0.361	3.085
hotmotel	1.431	0.459	3.118
comserv	0.736	0.264	2.785
mngbldg	0.491	0.157	3.138
food	-0.676	0.402	-1.681

Auxiliary Statistics	At Convergence	Initial
log likelihood	-516.94	-609.97
number of observations	880	
percent correctly predicted	68.75	

NTG Ratio 0.74

Alternative Specification 10

Participation Model

Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
c	1.482	0.460	3.219
sepmet2	1.144	0.448	2.554
mngbldg	0.770	0.427	1.804
kwhpre	0.000	0.000	0.742
lochghrs	0.041	0.026	1.571
bltbefor	0.395	0.527	0.750
inprog	1.020	0.698	1.460
hospclin	-1.163	0.832	-1.398
restau	-0.924	0.684	-1.351
misc	-1.223	0.620	-1.974

Auxiliary Statistics	At Convergence	Initial
log likelihood	-90.143	-321.62
number of observations	464	
percent correctly predicted	94.397	

Implementation Model

Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
c	-1.126	0.228	-4.945
ls	0.213	0.243	0.874
mngbldg	0.452	0.157	2.872
bltbefor	-0.758	0.171	-4.441
glaspct2	0.009	0.004	2.401
precdd	0.005	0.001	3.918
office	0.821	0.180	4.550
inprog	1.386	0.233	5.949
outprog	-0.220	0.090	-2.442
school	1.720	0.320	5.380
warehse	1.207	0.358	3.373
hotmotel	1.504	0.457	3.293
comserv	0.813	0.260	3.122

Auxiliary Statistics	At Convergence	Initial
log likelihood	-517.32	-609.97
number of observations	880	
percent correctly predicted	68.295	

NTG Ratio 0.29

APPENDIX H

Analysis Weights

Appendix H
Analysis Weights

Described below are the methods used to develop the appropriate premise-level weights for both participants and non-participants.

H.1 Participant Weights for Regression Analysis

The participant weights are based on the item/domain sampling ratios. The calculation of the premise weights depends on the number of items installed at each premise. For premises that installed only one item, the weight is calculated as the inverse of the probability that a given item for a given domain in the achieved sample at a given premise would be selected. For *each* premise, this is calculated as:

$$\frac{1}{n_{jh} / N_{jh}} \qquad (1)$$

where n_{jh} is the j^{th} item in the h^{th} stratum in the achieved sample n
N_{jh} is the population N for the j^{th} item in the h^{th} stratum.

For premises that installed *multiple* types of items, the premise level weight is the inverse of 1 minus the *joint probability* of the number of installations for a given domain in the achieved sample at a given premise *would not be* selected in the participant pool. For *each* premise, this is calculated as:

$$\frac{1}{\left[1 - \left(\prod_{j=1}^{n}\left(1 - \left(n_{jh} / N_{jh}\right)\right)\right)\right]} \qquad (2)$$

where n_{jh} is the j^{th} item in the h^{th} stratum in the achieved sample n
N_{jh} is the population N for the j^{th} item in the h^{th} stratum.

The application of these weights returns the 2,002 items rebated in 1994 and produces an estimate of 1,094 associated premises compared to our best estimate of 1,052 premises. A small downward adjustment factor (1,052/1,094) was used to adjust each premise-level weight in order to return the 1,052 premises.

A second set of premise-level weights was calculated in the manner described above that when applied to the 139 premises returns the 2,002 items rebated in 1994 and produces an estimate of 1,094 associated premises compared to our best estimate of 1,052. The same small downward adjustment factor (1,052/1,094) was used to adjust each premise-level weight in order to return the 1,052 premises.

A third set of weights was calculated to return the sample of 450 premises. These weights were calculated as the percent of the population in a given stratum divided by the percent of the sample in the same stratum. Such weights will result in small weights for strata that are overrepresented in the sample and larger weights for strata that are underrepresented in the sample. This second set of weights was calculated in the event that the weights designed to return the entire non-participant commercial premise population dominates, because of its sheer size, the models designed to estimate net impacts.

H.2 Non-Participant Weights for Regression Analysis

The population which we wish to represent by the non-participant sample is the total number of PG&E commercial premises (228,869) that did not participate in the 1994 PG&E Program. Four steps were required to develop weights to apply to non-participant premises.

1. Determine the number of commercial non-participant premises in 1994.
2. Determine annual kWh usage stratum membership for these non-participant premises. Stratum definitions are as follows:

stratum 1	< 15,999
stratum 2	>= 15,999 and < 40,000
stratum 3	>= 40,000 and < 102,081
stratum 4	>= 102,081 and < 341,500
stratum 5	>= 341,500

3. Using the same stratum definitions, determine stratum membership for the achieved sample of 450 non-participant premises that completed the telephone interviews.
4. Using this information, calculate the weights as:

   $$1/(n_h/N_h) \qquad (3)$$

   where N_h is the population N for the h^{th} stratum

   n_h is the achieved sample n for the h^{th} stratum

Note that in SAS the weight statement has no effect on the degrees of freedom or the number of observations.

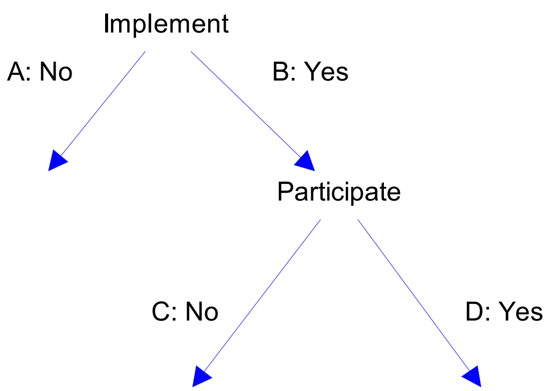
A second set of weights was calculated to return the sample of 450 premises. These weights were calculated as the percent of the population in a given stratum divided by the percent of the sample in the same stratum. Such weights will result in small weights for strata that are overrepresented in the sample and larger weights for strata that are underrepresented in the sample. This second set of weights was calculated in the event that the weights designed to return the entire commercial premise population may dominate models designed to estimate net impacts.

H.3 Participant/Non-Participant Weights: Discrete Choice Analysis

These weights are required by SST for estimating weighted logit models. A weight must be calculated for each alternative, in the same order as the indexing of the dependent variable. If each alternative indexed j has frequency q_j in the population and s_j in the sample, and these differ due to sampling alternatives, then the weights q_j/s_j yield consistent estimates. Below is described our calculation of weights for SST.

To make this easier to follow, refer to Figure H-1 which illustrates the "top" and "bottom" models and labels each branch A through D. Each option in the bottom model will have a unique weight and these weights will by necessity be different than the weights in the "top" model.

Figure H-1. "Top" and "Bottom" Models



Participation model

Participant Implementors		**Non-Participant Implementors**	
Pop	1,052	Pop	7,983*
Samp	438	Samp	26

* Calculated as (26/442)*135,719=7,983

Branch D:	# of participating premises in population that implement:	1,052
	# of premises in population that implement:	9,035
	Ratio:	**.116**
	# of participating premises in sample that implement:	438
	# of premises in the sample that implement:	464
	Ratio:	**.944**
	Weight (.116/.944)	**.123**
Branch C:	1 - .116	.884
	1 - .944	.056

	Weight (.995/.502)	**15.79**

Implementation model:

Implementors		**Non-Implementors**	
Pop	14,515**	Pop	215,406*
Samp	464***	Samp	416

*Best estimate of non-implementors among the population of non-participants (228,869 - 13,463)

** Calculated as 13,463 + 1,052 = 14,515
*** Calculated as 438 + 26 = 464

Branch B:	# of premises that implement in population:	9,035
	# of premises in population:	135,719
	Ratio:	**.067**
	# of premises that implement in the sample:	464
	# of premises in the sample:	880
	Ratio:	**.527**
	Weight (.063/.527)	**.126**
Branch A:	1 - .063	.933
	1 - .527	.473
	Weight (.937/.473)	**1.97**

APPENDIX I

Measurement Error

Appendix I

Measurement Error

In any given study, it may be the case that some of the variables being measured cannot be measured accurately, either because of data collection difficulties or because they are inherently difficult to measure. Errors in measuring the dependent variables are incorporated in the disturbance term and their existence causes no problems. However, when the errors are in the independent variables, the problems become quite serious, resulting in biased estimates. To see why this is the case, consider the following. Assume that:

$$x_i^* = x_i + v_i \tag{1}$$

where x_i is the true value

x_i^* is the observed value.

The true regression model is

$$y_i = \beta x_i + \varepsilon_i \tag{2}$$

while the actual regression run is

$$y_i = \beta x_i^* + (\varepsilon_i - \beta v_i) = \beta x_i^* + \varepsilon_i^* \tag{3}$$

To say that x is measured with error is to say that it is not fixed in repeated sampling. Instead, the values are generated by a random process as reflected by v_i in Eq. 1. In other words, the "observed" independent variable is a random variable, called a stochastic regressor, that is not independent of the disturbance term. Note that because the error ε^* and the variable x^* are correlated, a biased estimate will result.

In the case of a single explanatory variable, errors in measuring the variable causes the coefficient to be biased downward. When there is more than one independent variable, the direction of the bias is more difficult to determine. Also, in the case where there is more than one independent variable in the model, one of which we are certain was measured with a fair amount of error, there is also bias in the other coefficients, although the direction is unknown.

Random and Non-Random Error

There are two basic kinds of errors that affect empirical measurements: random error and non-random error. Random is the term used to designate all of those chance factors that confound the measurement of any phenomenon. The amount of random error is inversely related to the degree of reliability (precision) of the measurement instrument. That is, a highly reliable indicator is one that leads to consistent results on repeated measurements because it does not fluctuate greatly due to random error. The effects of random error are totally unsystematic in character. An engineering prior that contains random error is one that, in repeated measurements, sometimes overestimates the savings while at other times underestimates the savings. With respect to the estimation of HVAC savings, recent research suggests that some of this random error is probably due to the unreliability of estimates of operating hours. The second type of error that affects empirical measurements is non-random error. Unlike random error, non-random error has a systematic biasing effect on measuring instruments. Thus, an engineering prior that contains non-random error is one that, in repeated measurements, always results in either underestimates or overestimates of HVAC savings. Non-random error is very much related to the concept of validity (accuracy) which is defined as the net difference between the obtained measurement and the true value. Just as reliability is inversely related to the amount of random error, so validity depends on the extent of non-random error.

Concerns Regarding SAE Models

With this brief discussion of measurement error behind us, we will now turn our attention towards a particularly important variable used by many in the evaluation field, the engineering-based estimate of kWh impact used in SAE models. Some recent research has concluded that there is a serious problem with this variable. Sonnenblick and Eto (1995a and 1995b) have concluded the following:

> We find imprecision in hours of operation to have the largest effect on uncertainty of the resulting annual savings estimate. We also find, in our small sample, that hours of operation estimates the lion's share of bias to annual savings estimates. If future studies with a larger sample of programs can confirm these findings, it would suggest additional attention should be given to inexpensive and accurate methods for improving tracking database estimates of operating hours (p. 37).

They go on to add:

> Because the precision and bias of tracking database and site inspection estimates of savings seem to vary considerably, and because an evaluator, absent additional evaluation information, has no means of estimating the accuracy and precision of their tracking database estimate, it is dubious to rely upon tracking database estimates of savings alone.

This is entirely consistent with our recent experience at several utilities in which prior estimates of operating hours were very different from on-site measurements. Thus, we have every reason to suspect that the original PG&E engineering priors contain both non-random and random error. SAE models are designed to estimate the amount of systematic error or non-random error. For example, a realization rate of 80% indicates that a utility tended to overestimate savings systematically by 20%. If there is little random error in this utility estimate, then this estimate of 80% is unbiased. On the other hand, if there is a fair amount of random error in the measurement of the engineering prior, then the estimate of 80% is biased. The issue is how to minimize this random error in order to produce unbiased estimates.

Sonnenblick and Eto (1995) also concluded that there is considerable value in performing detailed site inspection, metering, and DOE-2 analysis in order to assess the tracking system accuracy (validity) and precision (reliability). The issue is how to leverage these data.