

Show Me the Attribution: Recommended Methods for Estimating Impacts for Finance Programs

*Jeevika Galhotra, Opinion Dynamics Inc., Oakland, California
Katherine Randazzo, Opinion Dynamics Inc., San Diego, California*

ABSTRACT

Finance programs are being implemented to help achieve energy savings goals. Evaluation of these programs helps describe the incremental effect of finance on participation beyond what is attributed to rebate programs that coexist with finance programs; i.e. to understand the distinction between the impacts of rebates and finance when both are used or available. Stakeholders would also like to know what ability finance programs have to drive energy savings on their own; i.e., for finance-only projects, what level of savings would have occurred absent finance offered through the program. However, understanding these programs in a complex and changing market is a daunting task and thus it is important to understand the environment in which they exist. These programs coexist with rebate programs and other finance alternatives, have multiple touch points, and have varied program scales, objectives and stages of development. These factors create several methodological issues when estimating the impact on a customer's decision to make an energy efficient upgrade. Given these challenges, attribution methods must evolve to provide credible evaluation results for finance programs. The authors guide readers through finance-specific issues faced by evaluators and recommend three methods that are preferable depending on program design from among thirteen designs studied (see Appendix): nested logit model, latent class discrete choice model and a self-report method.

Introduction

For achieving deeper energy savings, planners are developing and implementing energy efficiency programs that utilize finance as the primary vehicle. Two important issues we face in the field of finance program evaluation, which policymakers, program administrators and lenders are interested in learning about, are how to attribute credit for completing an energy efficient upgrade to finance versus rebates and how much savings can be achieved through finance-only projects (are finance programs helping “grow the pie” or simply replacing non-program alternatives). This becomes especially difficult when finance is offered simultaneously with rebates, when there are non-program finance alternatives in the customer's awareness, and/or when there is already a naturally-occurring demand for energy efficiency upgrades (for example, currently for solar upgrades). Given the complex marketplace within which these programs exist, estimating and answering these attribution questions can be equally complex. This paper presents the key issues that make up the complex marketplace within which finance programs operate and offers three recommended methods that help solve these issues and estimate attribution for these programs. However, the final attribution method(s) chosen will depend on the final program design and scale of the finance program under evaluation; this paper discusses what the authors consider to be the most promising approaches.

Key Issues when Studying Attribution for a Finance Program

The environment in which finance programs are implemented, as well as the variations across and within programs, creates several methodological issues when estimating program attribution. Below, we

discuss the key issues that must be considered prior to determining an attribution method(s) for a finance program.

Multiplicity of Finance Options, Alternatives, and Combinations. For any given finance program, there are several program and non-program options/alternatives available to both residential and non-residential customers. One of the most common configurations used by program implementers is pairing finance programs with one or more rebate programs, so a customer is able to get financing only if they participate in a rebate program or vice-versa. In other words, the frequent, but not universal combination of finance and rebates complicates an evaluation of financing's effects. Residential customers can opt for government finance programs, utility-based rebate programs, and/or private capital through the traditional finance vehicles such as home equity lines of credit, unsecured loans, private/retailer finance, credit cards, etc. Non-residential customers are similarly able to access alternative options including business lines of credit, energy service companies, or leasing arrangements (see Figure 1). In addition marketing of the various options/alternatives will be directed and received differently for different customer or geographic areas. Another issue that arises from so many options, pairings, and marketing strategies is that customers who would have used long-available financing options may simply substitute to financing through utility programs.

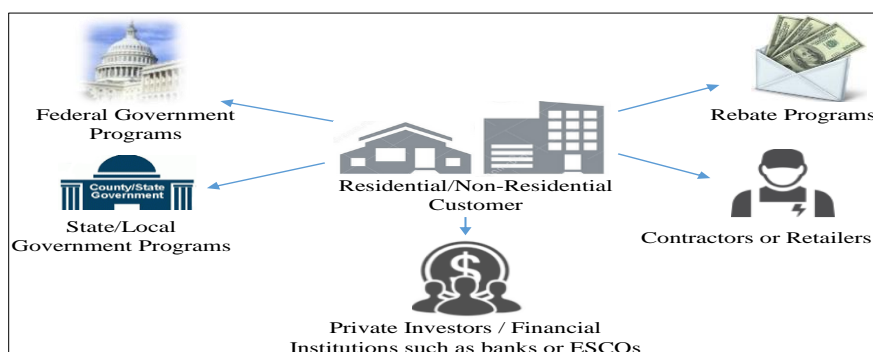


Figure 1. Finance Options and Alternatives

The multiplicity of overlapping finance options and marketing messages makes the task of parsing out each or one influence complex. To the extent possible, evaluators want to be able to understand why any observed change occurred, and whether it was due to increased availability of finance through the program or whether it was simply a shift from one finance option to the program.

Program Scale and Objectives. Program scale can be described in terms of number of participants and/or program offerings. Some programs may reach large numbers of participants, while others may only provide a handful of loans to households or businesses. Alternatively, programs may have varying objectives, for example a program is implemented to affect certain segments of the population focusing on project size as opposed to overall program participation. Given these differences, one should tailor the method(s) to the scale and objective of each program being evaluated. This tailoring would most likely be at the end of the program cycle unless the program magnitude (of participants and/or projects) is clear early on. Notably, the attribution method(s) must also match the scale of the program effort; i.e. evaluation budgets are typically aligned with program budgets.

Occurrence of Multiple Touch Points. Finance programs are often designed to influence more than just the customer making an upgrade; the programs also seek to influence upstream and midstream actors (see Figure 2). Similar to market alternatives discussed above, each level may need a different

attribution approach. While some effects of upstream and midstream interventions can be assessed within the method(s) chosen for downstream evaluation, one must think carefully about the various levels of market intervention when selecting the program-specific attribution method(s).

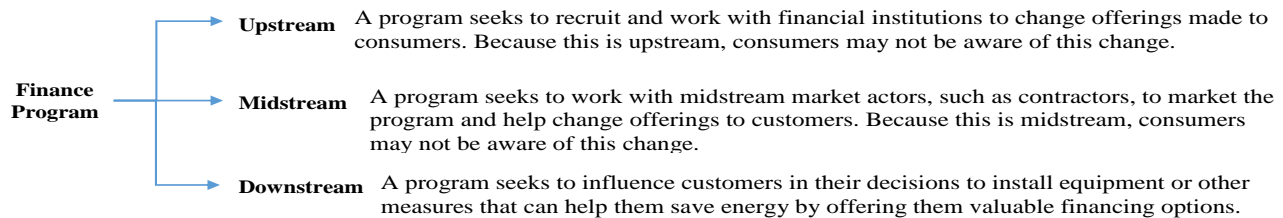


Figure 2. Three Points of Program Intervention

Stage of Program Development. It is important to understand when the various interventions are occurring, and to take that into consideration when determining the best timing for attribution research. Programs designed as pilots, for example, will generally experience changes in program design before a full rollout but could benefit from early exploratory attribution research. Alternatively, mature programs are already in their full rollout phase and are ready for final attribution work. Determining attribution before the start of a program or during the program cycle (with a small number of participants) requires methods that rely at least partially on conjecture, small sample sizes, and/or models employing stated preferences.¹ Whereas determining attribution values after the program cycle allows us to employ methods that use revealed preferences or self-reports of what the customer would have done without the program. The timing of the research itself can also influence the findings. Thus, one must consider it when determining the attribution method and presenting any results.

What is Needed to Address this Very Complex Situation?

Flexibility of method is the most important feature necessary for success when considering any attribution method for finance programs. Flexibility can allow the incorporation of information from multiple sources and takes into account program catchment areas and their overlaps. Flexibility can also allow identifying different exposures of customers to programs and to connect this with the level of customer awareness of the programs (and to connect customer awareness with different marketing efforts). In addition, while the attribution method(s) will need to be tailored to each specific finance program, to the degree possible, evaluators will want to look for methods that allow comparisons across programs. Using flexible methods offers the best chance for studies of other finance evaluations to use similar methods, thereby facilitating comparisons.

Given that customer decisions will be based not only on what is available, but also on what each customer brings to the decision, any effective evaluation design must take account of customer-level variables including but not limited to awareness of various program options pertinent to their upgrade decision, credit worthiness, motivations for an upgrade, potential constraints, and attitudes relevant to the decision. In addition, the evaluation design would require careful sampling. Ideally it would be able to capture in sufficient numbers both aware and unaware customers, customers who considered performing an upgrade project but did not, customers who completed a project but without permits², customers who completed a project without finance, customers who completed a project with non-program finance, and

¹ There are exceptions to this: revealed preference studies could be done early in the program if it is a high-volume program and there are therefore enough participants to provide revealed preferences.

² This data point represents part of the variation in customer choices. It is possible, e.g., that program finance reduces the number of projects done without permits.

customers who completed a project with rebates but not program finance. However, not all evaluations will require each of the above data points.

Recommended Methods

The authors examined various approaches to assessing attribution using the above-mentioned key issues, as well as other factors such as the scope of the study, the validity of the results, and the availability of data. We were able to narrow down the various approaches to the three methods discussed in this paper; nested logit discrete choice method, latent class discrete choice (LCDC) method, and a self-report method. A fourth, supplemental, method is multi-level modeling, which is not discussed in this paper but can be built upon the nested logit method and has the ability to predict continuous variables (e.g. project size) in a nested structure. In the appendix we show all methods considered and the criteria for choosing these three as the recommended methods. In general, we recommend applying a combination of these methods, which rely on a range of data sources, to help conduct rigorous attribution analysis.

For each method, we suggest a preliminary step: geocoding all customers in a sample or sample frame on program availability (of which there can be many), credit availability, and economic conditions. These conditions would frame all results obtained from any method used. In some methods, these codes can be applied as predictors. Below we detail each of the recommended methods along with their respective benefits and drawbacks.

Nested Logit Discrete Choice Model

Discrete choice models, including nested logit models have a very respectable history in the energy efficiency industry, though most of the rigorous studies using this method were done some time ago (Cambridge Systematics 1994; Itron, Inc. et al. 2010; Quantum Consulting 1998; Quantum Consulting 1999a; Quantum Consulting 1999b; SBW Consulting, Ridge & Associates, & KVD Research Consulting 2006; Train 2009; XENERGY 1993; XENERGY 2001). The typical nested logit model, and the one we recommend, uses revealed preference data to predict customer choices. Specifically, the authors recommend building a nested logit model to determine net effects when the scale of the effort is appropriate (i.e. program has sufficient participation). An important feature of this method is its flexibility in terms of defining customer decision points and what is used to predict them.

This method, using a simulator based on the model, will produce results showing the influence of rebates and finance separately and together. This method's reliance on revealed preferences benefits from dealing with actual choices, not hypothetical ones, with the preferences in this case being defined by the choices customers make to do or not do an upgrade, and if an upgrade is done, whether or not the upgrade includes energy efficiency measures. The model predicting these discrete choices would include variables indicating the availability and awareness of different finance options, rebates, and relevant covariates, such as credit worthiness of the customer. Some predictors can come from the geocoding, or from participant databases, secondary data sources (such as Census data, market interest rates, proxy credit scores, etc.), customer responses on loan applications, evaluation surveys, and from market-level data such as market actor interviews. The estimated model would serve as the basis for a simulator that allows us to evaluate the model with different relevant predictors turned on or off or set to mean values to produce estimates of probabilities with and without the program, and therefore attribution. The output of the model simulator allows us to calculate attribution for the program overall as well as among the customers who have used both finance and rebates and those who have used only finance or rebates; i.e. establish what portion of savings are attributable to rebate programs and what portion is attributable to the finance program(s). Additionally, if needed, the data gathered anticipating nested logit can be used to further analyze and predict continuous variables, such as project size, via multi-level modeling.

One value of this method is that it is able to integrate both consumer level data as well as data from midstream and upstream market actors. This would happen at the simulation stage where a program to, e.g., buy down interest rates could be assessed by evaluating the model at the non-buy down rate and then at the buy down rate to see the impact of the interest rate reduction that is associated with the program. This method can generally be applied to both the residential and non-residential sectors as long as there is a sufficient number of participants and non-participants in the relevant design cells. However, the weakness of the approach is the fact that rebates and finance so often co-vary in the real world. This means that there is a portion of the variation in decisions that cannot be parsed between the two influences.

The authors note that the decision to use this method should be delayed to late in the program cycle as, while it is possible to collect survey data as participants enter the program, there is always a risk that the program does not get sufficient participants and the method has to be dropped. Table 1 summarizes when to use this method and the various benefits and drawbacks.

Table 1. Summary of Nested Logit Discrete Choice Model

How this Method Helps in Attribution?	
<ul style="list-style-type: none"> • Helps in estimating attribution for finance and rebate programs so that the two can be distinguished • Helps in predicting discrete choices, including the availability and awareness of different finance options, rebates, and relevant covariates, such as credit worthiness of the customer 	
Recommendations for When to Use this Method	
Table key:	
✓ Method can/should be used for specified condition × We are not recommending for specified condition	
<u>Sector</u> ✓ Residential ✓ Non-Residential	<u>Scale of Effort</u> × Small # of participants ✓ Large # of participants
<u>Intervention Level</u> ✓ Downstream × Midstream × Upstream	<u>Timing</u> × In Planning Stage × During program implementation-if low volume ✓ After program cycle complete
Benefits	
<ul style="list-style-type: none"> • Flexible • Well understood and has established approaches to handle issues that may arise • Provides a more holistic view of the market by using a mix of data sources • Other models can be used on the same data if the need arises; (a) use multi-level modeling to predict continuous variables such as project size, (b) use multinomial logit if choices are not nested 	<ul style="list-style-type: none"> • Attribution can be weighted by project size • The survey can be relatively short and focused • Accounts for nested or clustered structures in the data (such as variability within the interest rates) • Does not rely on self-reported estimates of program influence (e.g. how much did the program influence your choice?) • Does not rely on self-report of a response to a hypothetical situation (e.g. what would you have done if the program were not available?)
Drawbacks	
<ul style="list-style-type: none"> • Requires a large number of participants which could be unknown at the start of a program • There are limits to how fine-grained the analysis can be, as a narrow focus on individual programs could result in too few cases in some of the design cells. Given that finance program participants may have installed any one or combination of many measures, it is easier to fill design cells than for 	

evaluations of single measures only. However, it does require substantial data collection among non-participants.

- Interpreting models can be complex especially in establishing causal direction. However, there are methods to deal with this, including modeling the result of questionnaire items asking about the influence of the program on the project.

Latent Class Discrete Choice (LCDC)

LCDC is used by a number of industries but has a somewhat shorter history in the energy efficiency industry, in which its first time use may have occurred in 2006 (Ridge & Associates, KVD Research Consulting, & StatWizards 2006; Randazzo et al. 2013). It is a method based on customers' stated preferences that helps determine the factors or attributes that influence customers' choices about whether to do an upgrade, whether to do an energy efficient version, whether to use finance for it, and to estimate the degree of influence of a rebate. This method allows program planners to assess what the uptake rate would be for programs with any bundle of attributes/values the planner wishes to consider. It also allows for the possibility that different types of customers will have different preferences as it performs a segmentation analysis simultaneously with identifying choice patterns. It also provides more flexibility than revealed choice methods in the variety of program characteristics that can be incorporated into the available choices. The method will produce attribution results overall and by segment. We do not recommend this as a standalone method but as a valuable input to final attribution calculations, and for use as a planning tool.

This method presents choices to customers in a way that mimics real-world choices, i.e. choice sets or bundles are presented, not individual attributes or just one generic program design. This is typically accomplished in an online format.³ For a finance program, the respondent would be presented with multiple choice sets of 4-8 choices with different configurations of finance and rebate options, combined with upgrade projects that include or exclude energy efficiency attributes. The respondent indicates which option they would choose, including "none of the above." Giving them a choice of 'none of the above' is an important element in grounding the research in reality. The choice bundles are designed to reflect a variety of attributes and a range of values on them that are realistic. The bundles are designed by an experimental design.⁴ Choosing these features or attributes is a critical part of the design process for this study. We must select which attributes of the programs we think are important to customers in making the decision to do a project or not. Thus, an important part of each upgrade project presented to the customer should be the rebate and finance program features "available" to them as part of their choice. In addition, important attributes of the project, including whether it is to be an energy-efficient one or not, are part of the design. This allows us to study just how important rebates and finance are separately and together without the constraints of how these options are actually available and presented to the customer in life.

A simulator is produced from the estimated model that allows program planners to assess what the uptake rate would be for programs with any bundle of attributes/values the planner wishes to consider. The simulator produces probabilities of customers doing an efficient upgrade both with and without the program(s) by the usual method of setting predictor values to represent the two conditions. These

³ Data for this method can be collected via mail survey (and was for many years) or a mailed instrument combined with a telephone interview to take the respondent through the survey. We recognize that there is reason for concern about biases associated with internet surveys; however, the representativeness of an internet sample is getting less concerning as access to high-speed internet is more ubiquitous.

⁴ To be clear this does not refer to a design where customers are randomly assigned to treatment conditions. It refers to the random assignment of attributes to option bundles offered to respondents such that the effects of one attribute (e.g. rebates) can be cleanly estimated and separated from another (e.g. finance).

probabilities form the basis for calculating anticipated attribution results. The software also provides information for assessing the cost effectiveness of customers' preferred options.

By using this method during the program implementation period, this short-term study can be used to estimate an interim attribution number during program implementation with the end of program cycle study then providing final estimates of attribution for the future. However, the results of the LCDC should not be discarded once revealed choice modeling has been completed. At a minimum, they should be used as a point in triangulation as well as a method to apportion the joint effects of rebates and finance identified by the revealed choice models. At the end of the program cycle, a multi-method approach can be used to provide evidence on which a final decision about attribution can be made. Table 2 summarizes when to use this method and the various benefits and drawbacks.

Table 2. Summary of LCDC Model

How this Method Helps in Attribution?	
Allows program planners to assess what the uptake rate would be for programs with any bundle of attributes/values the planner wishes to consider (e.g. interest rates, level of rebates offered etc.)	
Recommendations for When to Use this Method	
Table key: ✓ Method can/should be used for specified condition × We are not recommending for specified condition	
<u>Sector</u> ✓ Residential ✓ Non-Residential	<u>Scale of Effort</u> ✓ Small # of participants ✓ Large # of participants (however do not need to wait to have high uptake)
<u>Intervention Level</u> ✓ Downstream × Midstream × Upstream	<u>Timing</u> ✓ In Planning Stage ✓ During program implementation × After program cycle complete
Benefits	
<ul style="list-style-type: none"> • Can distinguish the effect of finance vs rebates • Allows great flexibility in program features to be tested and on outputs produced • Can predict both choice to do a project and size of project with and without finance • Tells us what configurations or bundles of product attributes are most favored by potential customers • A planning attribution ratio can be established based on stated preferences • Program design/offerings could be modified based on predicted customer choices and uptake rates • Predictions can be done overall and for defined segments 	<ul style="list-style-type: none"> • Allows for the possibility that different types of customers will have different preferences • Can get attribution answers based on comparison of realistic market representations (i.e. choices are made in context of what is available outside program) • Provides a wealth of information for program planning purposes, including elasticities, assessment of possible future programs-what it would take to have a program that influences customers' decisions to take action, and whether that design would be cost effective • The method deals with nested structures and the problem of Independence of Irrelevant Alternatives (IIA)
Drawbacks	
<ul style="list-style-type: none"> • Relatively new for the energy efficiency industry (but has been widely used in other industries) 	

- Results are typically based on stated not revealed preferences - data can be based entirely on stated preferences of non-participants, although there are multiple ways that stated preference results can be calibrated. One possibility is including participants and customers who have done upgrades recently. Another way is to use secondary data to create adjustment factors.

Self-Report Method

Self-report is the most commonly used method for attribution for many program types. It is specified as an acceptable method for estimating attribution, though preferably in combination with other methods. It does have some well-known weaknesses, and usually should not be used as a stand-alone method. However, it has so much flexibility, and a relatively low-cost, that the authors argue for including it among other approaches. This method is based on answers to multiple questions on a questionnaire. The questionnaire design specifies questions to catch answers that are not internally consistent or logical so that evaluators have confidence in the internal validity and reliability of the results. The questionnaire asks respondents to respond to the questions about program influence on a scale so that analysts can easily translate results into probabilities of program influence. The questionnaire also asks respondents to directly estimate program influence and to say what they would have done absent the program. Respondent answers are combined to estimate program attribution. The self-report battery of questions should include questions that both compare attribution estimates across rebate and finance programs and help establish a method for understanding the incremental effect of finance on participation and overall energy savings beyond what is already attributed to rebate programs that coexist with finance programs.

To improve the rigor, the evaluation could draw from multiple sources to modify the self-report method. The modified self-report method uses the data collected through the self-report effort and augments it with data from other sources, such as contractor interviews. This method can help inform us about not only what participants would have done in the absence of the program, but how the program and market actors are influencing participation.

For our purposes, this method is also quite flexible on a number of dimensions. It is flexible in the timing of data collection, so can be oriented to what was available to a given customer at a given time (from the preliminary geocoding of the customer). It is also flexible in terms of what programs and marketing efforts can be addressed for each customer. In addition, it can be used to collect information that can only be obtained through directly asking the customer, such as motivations and attitudes. And, the survey can be focused on distinguishing between the influence of rebates versus finance. The timeline for this method is dependent on the implementation timeline of programs. While participant surveys can begin any time after implementation of the program, an aggregate final attribution ratio should not be determined until the end of the program cycle. Table 3 summarizes when to use this method and its various benefits and drawbacks.

Table 3. Summary of Self-Report Method

How this Method Helps in Attribution?	
<ul style="list-style-type: none"> • Direct reporting of attribution from the program participants • Improves rigor of the attribution findings through use of other sources (e.g., contractor interviews) 	
Recommendations for When to Use this Method	
Table key:	
✓ Method can/should be used for specified condition	× We are not recommending for specified condition
<u>Sector</u>	<u>Scale of Effort</u>

<ul style="list-style-type: none"> ✓ Residential ✓ Non-Residential 	<ul style="list-style-type: none"> ✓ Small # of participants ✓ Large # of participants
<u>Intervention Level</u> <ul style="list-style-type: none"> ✓ Downstream ✓ Midstream* ✓ Upstream* <p>* dependent on whether participants can be identified</p>	<u>Timing</u> <ul style="list-style-type: none"> × In Planning Stage ✓ During program implementation* ✓ After program cycle complete* <p>* dependent on objective</p>
Benefits	
<ul style="list-style-type: none"> • Flexible and simple approach • Well understood and has established approaches to handle issues that may arise 	<ul style="list-style-type: none"> • Attribution can be weighted by project size • Provides a more holistic view of the market by using a mix of data sources
Drawbacks	
<ul style="list-style-type: none"> • Respondents may bias responses in a socially-desirable direction or in the direction to influence the continuation of the program • Results do not help determine what program changes would be required to improve the attribution ratio. This is particularly important in finance evaluation because of the wide variety of programs and attributes, and the many possible future configurations. 	<ul style="list-style-type: none"> • Evaluators often assign different weights to different question responses which can be arbitrary and subjective and can have a substantial effect on the resulting attribution ratio • To get results for each program type, samples of participants in each program would have to be large enough to produce an independent estimate for that program.

Comparison of the Three Methods

While all methods have some inherent limitations, some of these limitations can be solved by using multiple methods, as recommended by the authors. Table 4 summarizes how each recommended method can help solve some of the weaknesses of the other attribution methods.

Table 4. Comparison of Proposed Methods of Attribution

Weaknesses of Attribution Method	Recommended Methods to Help
Self-Report: <ul style="list-style-type: none"> • Potential social desirability bias • Potential desire to support program bias • Potential recall bias • Hypothetical alternative bias • Limit to how many alternatives can be covered in survey 	LCDC: <ul style="list-style-type: none"> • Self-enhancing choices are not obvious to customers • Options that would support programs are not obvious • No recall involved-all present choices • All choice alternatives on equal footing, with possibility of calibration to external data and participant data provides grounding • Alternative attributes and levels embedded in choices-no need to ask about each separately
Nested Logit: <ul style="list-style-type: none"> • Choice alternatives are confounded due to confounding in real world-programs usually offered together and decisions made 	LCDC: <ul style="list-style-type: none"> • Experimental design used for presenting alternatives so attributes and levels do not co-vary, and each presented the same number of times; provides the best possible chance to separate influences cleanly

Weaknesses of Attribution Method	Recommended Methods to Help
simultaneously so may be impossible to separate rebate from finance influence <ul style="list-style-type: none"> • Can be hard to fill design cells based on actual decisions • Some may not be aware of alternatives, thus restricting their choices-cannot study a trade-off that was not possible • Does not estimate impact of finance on project size 	<ul style="list-style-type: none"> • The balanced design assures enough choices of each kind available for analysis • All participants are aware of all alternatives, allowing us to study all trade-offs and effects of non-awareness • Multi-level modeling estimates impact on continuous variables like project size, models any nesting structure
LCDC: <ul style="list-style-type: none"> • Based on stated preferences-possible hypothetical bias • Does not estimate impact of awareness 	Nested Logit: <ul style="list-style-type: none"> • Based on revealed preferences • Directly estimates impact of awareness

Conclusion

Given the complexities that exist in evaluating a finance program, a thorough evaluation should consider the overall program design, the scale of the effort, the flexibility to capture all aspects of the program within the evaluation methodology, and the availability of data when considering a methodology for estimating attribution. The attribution evaluation should address 1) the relative impact of finance and rebates, and 2) the incremental impact of finance as compared to non-program finance and other payment alternatives. Keeping these and the various market issues in mind, the authors recommend using multiple approaches as no one approach is sufficiently flexible and rigorous. Specifically, we recommend that LCDC be used for its flexibility in addressing multiple issues, but especially because it will provide the cleanest distinction between finance and rebate impacts. We recommend using the nested logit discrete choice model for its flexibility in addressing multiple market issues and the fact that it is based on revealed preferences. We recommend using the self-report method because of its flexibility and direct participant approach.

Appendix

Table 5 and Table 6 show our analysis of each study design that we considered. We stressed flexibility on four dimensions because the varied nature of the program(s) creates complexity and more flexibility will allow evaluators to modify plans as needs arise. The heat map shows that the three recommended methods have a greater number of positive attributes compare to the other ten methods.

Table 5. Criteria for Selecting Methods

Criteria	Definition
Flexibility: Geographic Availability	Whether method would provide a test of the impact of differences in availability
Flexibility: Timing or Scale	Whether method can adapt to differences and/or changes in the program's timing or scale
Flexibility: Program Attributes	Whether method is able to test one program attribute against another for determining what customers value
Flexibility: Upstream Effects	Whether method can incorporate and represent the influences of upstream and/or midstream market actors
Internal/External Validity	Whether results from the method are likely to have serious problems in internal and/or external validity
Data Availability	Whether it would be feasible to collect all the necessary data to conduct the proposed method
Separation of Finance and Rebate Effects	Whether method would be able to separate out the effects of rebates vs. finance on influence on customer decisions to use finance

Table 6. Heat Map of Critical Design Characteristics

Methods	Flexibility: Geographic Availability	Flexibility: Timing or Scale	Flexibility: Program Attributes	Flexibility: Upstream Effects	Internal/External Validity	Data Availability	Separation of Finance and Rebate
Self-report	●	●●	●	●	●●	●	●
Nested Logit Model (+ multi-level modeling)	●	●	●	●	●●	●	●
Latent Class Discrete Choice	●●	●●	●●	●	●●	●	●●
Expert Panel	●	●	●	●	●●	●	●
Analytical Hierarchy Process	●	●●	●	●	●●	●	●
Structural Equation Model	●●	●	●	●	●●	●	●
Regression Discontinuity	●	●	●	●	●●	●	●
Quasi-Experimental (pre-post w/comparison group)	●	●	●	●	●●	●	●
Pre-Post (no comparison group)	●	●	●	●	●●	●	●
Experimental Design	●	●	●	●	●●	●	●●
Case Studies/Expert Reports	●	●	●	●	●●	●	●
Focus Groups	●	●	●	●	●●	●	●
In-depth Interviews with Market Actors (Pre-Post)	●	●	●*	●*	●●	●	●
*From market actors' perspectives ●● - Positive feature of the method ● - Not a concern/limitation ● - Some concern/limitation ● - Definite concern/limitation							

References

- Cambridge Systematics. 1994. *Customer Decision Study: Analysis of Residential Equipment Purchase*. Prepared for Southern California Edison Company.
- Itron, Inc., ECONorthwest, KEMA, Inc., PA Consulting, Summit Blue, Robert Thomas Brown Co. 2010. *Small Commercial Contract Group Direct Impact Evaluation Report*. Prepared for the California Public Utilities Commission Energy Division. Appendix F.
- Quantum Consulting. 1998. *1996 PG&E Commercial Energy Efficiency Incentive Program: HVAC Technology*. Prepared for Pacific Gas & Electric Company.
- Quantum Consulting. 1999a. *1997 PG&E Commercial Energy Efficiency Incentive Program: HVAC Technology*. Prepared for Pacific Gas & Electric Company.
- Quantum Consulting. 1999b. *1997 PG&E Commercial Energy Efficiency Incentive Program: Lighting Technology*. Prepared for Pacific Gas & Electric Company.
- Randazzo, Katherine, Anne Dougherty, George Boomer, Richard Greenburg, and Brett Close. 2013. "Taking LEDs to Market: Designing a Comprehensive Market Trial that Examines Incentive Levels and Consumer Preference." In Proceedings of 2013 IEPEC Conference, Washington, DC.
- Ridge & Associates, KVD Research Consulting, & StatWizards. 2006. *Final Report for the Evaluation of the California 2003 Home Energy Efficiency Survey Program and the Southern California Edison Local In-Home Energy Audit Program*. Prepared for Southern California Edison Company, Pacific Gas and Electric Company, San Diego Gas and Electric Company, and Southern California Gas Company.
- SBW Consulting, Ridge & Associates, KVD Research Consulting. 1995. *The evaluation of PG&E's 1994 Commercial HVAC Program*. Prepared for Pacific Gas & Electric Company.
- TecMarket Works, Megdal & Associates, Architectural Energy Corporation, RLW Analytics, Resource Insight, B & B Resources, Ken Keating and Associates, Ed Vine and Associates, American Council for an Energy Efficient Economy, Ralph Prahll and Associates, and Innovologie. 2004. *The California Evaluation Framework*. Sacramento, CA: California Public Utilities Commission and the Project Advisory Group.
- Train, Kenneth. 2009. *Discrete Choice Methods with Simulation, 2nd Ed*. Cambridge University Press: New York, NY.
- XENERGY. 1993. *Commercial, Industrial, and Agricultural Retrofit Incentives Program Net-To-Gross Ratios for PG&E's CIA Rebate Program: Study D - Decision Analysis Model*. Prepared for Pacific Gas & Electric Company.
- XENERGY. 2001. *Improving the Standard Performance Contracting Program: An Examination of the Historical Evidence and Directions for the Future: Final Report*. Prepared for Southern California Edison Company.