MEASURING MARKET TRANSFORMATION DUE TO PRIOR UTILITY EFFORTS

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Introduction

Participant spillover is defined as energy-conserving actions taken by program participants that fall outside the specific program(s) offered. Non-participant spillover is defined as customers who are not participants in identified programs, but are stimulated by those programs to carry out the same energy-efficient actions. This includes customers who adopt measure due to changes in stocking patterns, i.e., free drivers. (See ESEERCO, 1994, pages 1-4 through 1-6; and Association of Energy Services Professionals, 1994, sections 1 and 2.)

Participation and spillover can help create market transformation. The market transformation created from prior program actions can itself create participants who may answer that they intended to take the actions anyway. In standard annual evaluations, the stated intentions of these participants cause them to be designated as free riders. Yet, they may only have these intentions because of prior program efforts. Prior definitions and evaluation measurement approaches on a static basis do no properly consider how these definitions change when examined over time.

The market transformation (MT) caused by prior program actions can mean that the lines between measurement of program impact and a particular year's measurement of free ridership become blurred. Today's free-riders may have been caused by yesterday's market transformation. Programs that move the market would be expected to create free riders as defined by self-reported intentions. This is the area of overlap between the measurement of market transformation and the measurement of a particular year's free riders.

This paper presents how market transformation from prior utility efforts was considered and measured within a study to measure free ridership (net of this market transformation for Consolidated Edison Company of New York's commercial and industrial rebate programs.

Market Transformation and the Standard Utility DSM Program

Time is part of the definition of market transformation in that its definition includes the persistence of the effect. Examining program effects over time, instead of the previously static examination of free riders and spillover, quickly provides us with a view of the potential overlap between free ridership, spillover, and market transformation as they relate to standard utility DSM program efforts.

Overall market transformation can be caused over time by a variety of standard utility DSM programs. In fact, market transformation was often the primary goal of DSM as they were being developed in the early 1980's. Generally, these programs were never designed to be permanent efforts, but were designed to overcome market barriers and demonstrate to customers the benefits and cost-effectiveness of energy efficiency equipment and actions.

DSM programs were mandated by regulators in order to increase the amount of DSM investments. One of the reasons for this was that DSM has external benefits. Goods and services with external benefits will be under-invested in from a societal maximization perspective. This results from the fact that energy efficiency has greater benefits for society, lower pollution and overall costs, than is seen in the individual customer's decision-making process.

In classical microeconomics, the marginal social benefits (MSB) are greater than the overall demand curve. Society's desired DSM quantity and price are significantly greater than the market equilibrium, a case of market failure. This is illustrated in Figure 1. In Figure 1, the market equilibrium is at quantity Q_o at price P_o. The societal optimum would be at quantity Q_{soc} at price P_{soc}. The cost of the market failure to society is the difference between these equilibriums $(P_{soc} - P_o) * (Q_{soc} - Q_{soc})$. This is one of the reasons regulators required greater DSM investments than the utility would otherwise make.

A utility rebate program in economic terms is offering a subsidy to the consumers of energy efficiency equipment. This increased their short-run demand for the product by making the price the consumer sees P_o while the price the market sees is P_1, as shown in Figure 2. This subsidy, at least while it is being made, increases the price to P_1 and the quantity to Q_1. As shown in Figure 2, this subsidy causes the market quantity and market price to approach the societal optimum level.

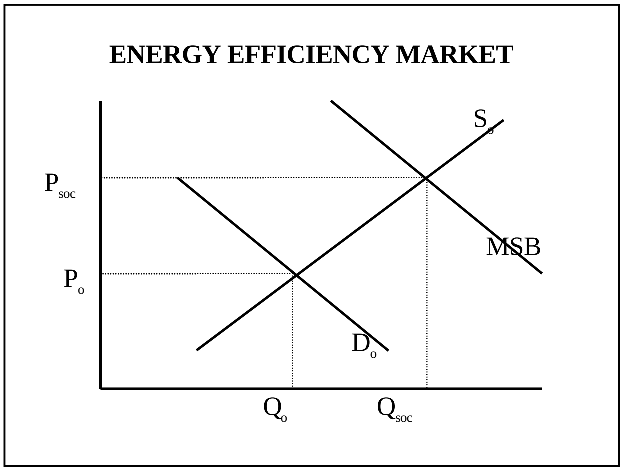

Figure 1

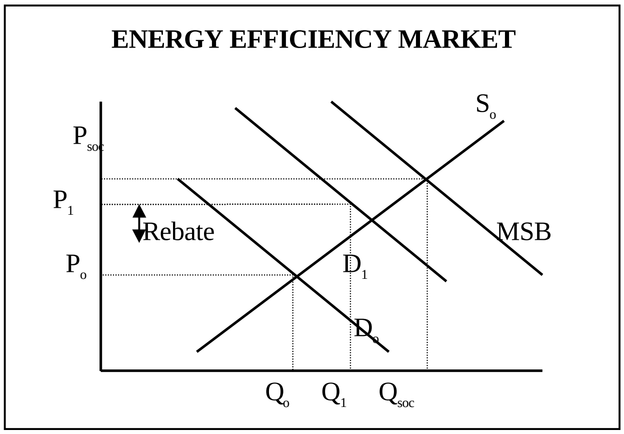

Figure 2

If the only market barrier is the price of energy efficiency, once the rebate is removed demand will return to D_0. However, if market barriers include doubt about new products, or whether energy efficiency is truly cost-effective, then the rebate-induced trial of the equipment could cause a decrease in these market barriers. If there is a decrease in non-price market barriers, then the rebate program could cause market transformation. Market transformation here is represented as a permanent shift to D_1 after the rebate is removed.

Standard utility DSM programs have also been targeted to the supply-side. For example, there have been dealer rebates to induce dealers to expand their marketing and stocking of energy efficiency products. These rebates also appear as a subsidy. In this case, however, they shift the supply curve to S1. Again, the quantity of energy efficiency products sold increases to Q1. This is shown in Figure 3.

Similar to the demand-side rebates, the supply-side rebates can cause market transformation if they cause a reduction in other non-price market barriers. Also, the supply may fall back to S_o when the rebate is no longer offered if the only barrier is the equilibrium price.

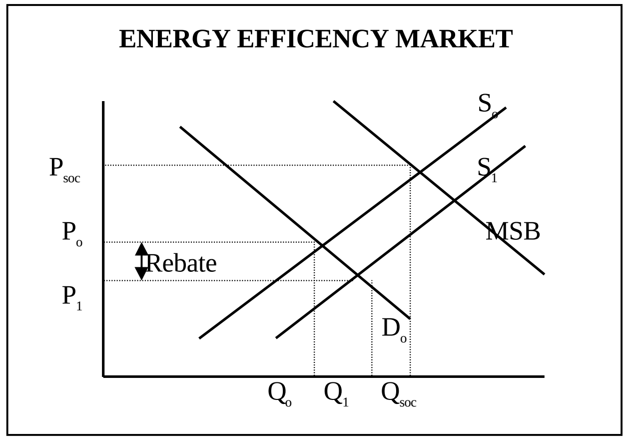

Figure 3

Standard utility DSM programs have often used both approaches. We see in Figure 4 how these can cause the quantity of energy efficiency to approach the societal optimum without causing much change in the market price.

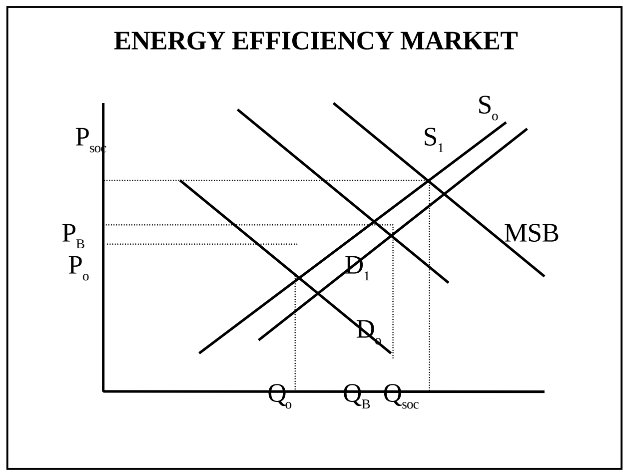

Figure 4

If standard utility DSM programs can create market transformation, how do we measure this effect? In many studies the approach to this problem has been a top-down approach. A top-down approach examines the overall market via sales data trends, or stocking and supply information. These types of studies have significant difficulties in obtaining data and in estimating accurate program impacts.

Standard DSM evaluations have often been conducted with a bottom-up approach. That is, we measure the program impact on the individual customer and aggregate up the impacts to the overall program impact. This type of approach is what was used in this study's examination. We also only examined one component of market transformation, the area where free ridership overlaps with market transformation.

Today's free-riders may have been caused by yesterday's market transformation. This is illustrated graphically as compared to gross savings, naturally occurring savings (free ridership), spillover, and market transformation in Figure 5 as the white semi-circle portion of free riders. This is the area of overlap between market transformation and gross (static one-year estimate) free riders.

A more in-depth review of the variety of market transformation definitions being discussed, and our choice of examining the overlap between market transformation, spillover from prior utility efforts, and free ridership is provided in a proceeding paper also based on this project, Megdal et. al., 1996. (A more in-depth discussion of market barriers and programs to address these can be found in Eto, Prahl, and Schlegel, 1996.)

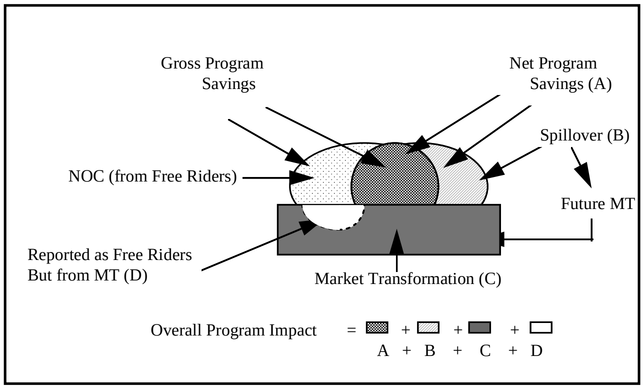

Figure 5

The mis-measurement of market transformation customers as current free riders is similar to the measurement issue presented by Saxonis in 1992 of misidentifying free drivers' actions as free riders. Prior studies also provide empirical indications of this occurrence. In the 1994 review study by Mast and Ignelzi, they cite strong evidence for significant occurrences of this phenomenon.

> "Rathbun et al. found that estimates based on self-reports from participants and non-participants indicated free-ridership on the order of 55-75% for a Wisconsin Public Service air conditioner incentive program (Rathbun et al. 1990). Yet prior to the program, efficient air conditioners made up only 17% of purchased stock. Rathbun explained the discrepancy by noting results from a trade ally survey indicating that the direct rebate program had a strong impact on dealer stocking and promotion practices. If such was indeed the case, then both participant and non-participant self-reporting would systematically overestimate the proportion of free-riders and underestimate the proportion of free-drivers." (pp. 10.150)

Programs that move the market would be expected to create free riders as they are defined by self-reported stated intentions. This phenomenon can be estimated from information provided in an article by Gallaher and Wiecek in 1995 concerning a study of Niagara Mohawk Power Corporation's High Efficiency Motors program. They estimated market movement from a model predicting the probability of installing high-efficiency motors. From this model, they estimate that market movement had gone from a probability of installing high-efficiency motors of 33% to 43%, and that without incentives the probability after the program would be 40% (p. 845). That is, an additional seven percent of customers would install the high-efficiency motors without an incentive after the program than before. This equates to almost 18 percentage points as a free ridership estimate after the program (7%/40% who install). These customers would be truthfully answering their intentions to make the installation without the program. Yet, the installations would never have occurred without the earlier program.

Measurement Concept

At this time, we are only attempting to measure the much smaller impacts of market transformation, those that create participants classified as free riders by the Stated Intentions methodology. (This is the white semi-circle in Figure 5, where free riders overlap with the customers impacted by market transformation.) A much larger study would need to be undertaken to measure the greater spillover and market transformation effects created by Con Edison's program(s) on the larger customer population.

Measurement Philosophy

An important element of this investigation included asking participants questions concerning when they received information on the rebated technologies and the importance of information from Con Edison in their decision to install. How long have they been aware of these technologies? Have they participated in Con Edison sponsored programs in the past (including receiving an energy audit)? Has the respondent (energy facility manager) personally participated in one of Con Edison's residential DSM programs?

Few of these areas being examined are new. The main difference in this study is in examining the outcomes alongside what we also learn about those participants who are self-reported free riders, i.e., they say they would have made the technology adoption if the program had not existed. For example, consider the following two participants:

Participant One's survey responses indicate they:

- Definitely would have installed the equipment in the absence of the program (a free rider by Stated Intentions);
- Received an energy audit from Con Edison at least a year prior to program participation;

- Received information on the rebated technology from Con Edison prior to their installation of this technology in their facility; and
- Has not made other possible energy efficiency investments.

Participant Two's survey responses have the same response to the self-reported stated intentions' question, but very different responses to the other questions. These responses are:

- Definitely would have installed the equipment in the absence of the program (a free rider by Stated Intentions);
- Has not received an energy audit from Con Edison;
- Purposefully gathers information on energy efficiency; and
- Has made all other possible energy efficiency investments.

Both of these participants would initially be classified as free riders. Yet, the first would be removed from the calculation of the free ridership factor by this step as being induced by Con Edison's programs to take these intended actions. The second participant described here is a net free rider while the first is not due to market transformation effects.

Prior Program Penetrations and Size of Affected Participant Population

There are skeptics that think that standard DSM programs can not create market transformation because their total market penetration is too small. The annual market penetration of a DSM program can be small and still the long-term penetration from that program can be quite significant.

Our first data examination is to look at the extent of penetration of Con Edison's programs as seen through survey responses from participants and non-participants. The non-participant sample was taken from billing records. Firms that showed up as participants from January 1, 1995 through April, 1996 were deleted from the non-participant sampling frame. A stratified random sampling was performed for the non-participant survey sampling frame to assure representation of large customers (with demand equal to or greater than 1.5 megawatts), and all industry categories. The obtained survey sample is then weighted to represent Con Edison's total non-participant pool. The penetration rates for participants and non-participants are presented in Table 1.

Non-participants were defined by not being found in the participant pool of January 1995 through April 1996. Yet, 21% of non-participants have received an energy audit from Con Edison. Almost half of the non-participants receive over half of their information on energy efficiency from the utility. Prior participation among participants is also significant, with more than half (51%) having participated in other utility programs (more than one report program in the last five years), and 54 percent having received an energy audit by the electric utility.

Table 1: Penetration Rates

	Participants	Non-Participants
Received audit by electric utility	54%	21%
Ever participated in utility energy efficiency program	70%	13%
In rebate program in last 2 years	NA	3%
In rebate program in last 5 years	NA	8%
More than 1 rebate program in last 5 years	51%	3%
Decision-maker in residential EE program	7%	11%
Seen Con Edison's Ads on EE lighting	74%	41%
Seen Con Edison's Ads on EE AC	33%	13%
Seen Con Edison's Ads on EE or VSD Motors	24%	8%
50% or More of EE info received is from Con Edison	42%	48%

(This table supersedes a similar prior table reported in Megdal, Pertusiello, and Jacobson, 1996.)

These levels of penetration could easily be expected to create spillover and market transformation. Participants who have received utility energy audits, energy efficiency advertisements, and earlier program participation could truthfully say that they would have made the efficiency investment without the utility's 1995-1996 incentive. Yet, it would be misleading to denote all these participants as free riders when many may have been influenced by Con Edison's programs and their market transformation (i.e., the earlier efforts may have shifted the energy efficiency demand curves for these customers). It is these customers we are identifying and for whom we are adjusting our free ridership factors in the Step 4 Adjustment.

Table 2: Proportion of Con Edison's Free Riders* That Are Subject to a MT Effect

	Received Audit	More than 1 program	Seen utility's EE Ads	Any of these Three
Lamps	17%	14%	26%	31%
Customized lighting	25	22	32	37
CFLs	17	17	17	24
Fixtures	21	13	27	33
Ballasts	19	13	27	35
Lighting controls	29	30	57	58
AC & Chillers	31	38	14	52
VSD	7	36	21	36
EE Motors	25	31	37	50

* Defined as those participants with a 60% or greater probability and/or partial NOC measurement.

The estimate of the number of effected participants from the Step 4 Adjustment is provided within Table 2. Table 2 examines the percentage of self-reported free riders who have participated in earlier utility energy efficiency efforts, i.e., the percentage of self-reported free riders subject to a market transformation effect. Between 20 and 50 percent of the self-reported free riders (with a 60% free ridership proportion) have received assistance from a prior Con Edison energy efficiency program.

Magnitude of Prior Program Effects

Knowing that a participant has been influenced by earlier program activities still did not tell us how much influence the prior program had on their decision to install. The magnitude of the effects of prior program activities were estimated by using installation regressions for participants and non-participants. In order to capture the element of the effects over time the dependent variable in the regressions was the percentage of an end-use that had energy efficient equipment, not whether energy efficient equipment had been installed in the last year at a particular location. The regressions included both participants and non-participants with the independent (causal) variables being program participation, and the prior program participation variables.

The study was not designed for this modeling effort. As such, the data collected did not allow us to test and obtain models with high levels of explanatory power (high R-squares). It is also much more difficult to model the cumulative effect of many decisions on the total percentage of installations that are efficient than to model an individual decision at one point in time. However, the models do enable us to provide an estimate of the overall magnitude of the effects of prior program and advertising provided by the utility as compared to the effects of the rebate. It is this comparative magnitude that is being used from the models, not exact coefficient estimates. In other words, the use of the results is modified and is in keeping with the expected accuracy of the models.

In many cases, the effects of prior program activities were as great as the effect of the current rebate program. The strength of this effect was much greater than was anticipated. This provides strong evidence that standard utility efficiency programs significantly influence the future efficiency decision-making of participants. It also demonstrates that many of the participants who have not been counted in recent DSM evaluations due to their being free riders may actually be making these decisions due to earlier utility efforts, market transformation.

Tables 3 through 8 provide the installation regression results.

Table 3: % of Ballasts' That are Electronic or High Efficiency

Variable	Parameter Estimate	T-Value
Ballast rebate	13.34	2.29
Past participation	17.22	3.96
Audit	14.08	3.07
Ads for effic. lighting	17.43	3.89
Intercept	41.72	12.20
Adjusted R-Square	0.2138	

These regressions were general linear models. It is recommended that future studies incorporate the self-selection bias of the participants in the model design. We understand that the actual measured coefficients in this study are likely biased. Yet, in this study we only used the relative approximate magnitude of these coefficients. For this limited purpose, the results are sufficiently accurate.

Most of the prior econometric work that corrects for self-selection bias currently uses nested logit models (Train et. al., 1994 and 1995). However, the dependent variables in this study are not one time installation decisions but continuous variables that are the cumulative effect of these decisions over time. Nested logits in this case are not appropriate. This complicates the methods needed to obtain unbiased accurate coefficients for this type of analyses.

Table 4: % of AC & Chiller Tonnage That is High Efficiency

Variable	Parameter Estimate	T-Value
AC rebate	12.91	1.45
Past participation	6.29	1.16
Audit	22.45	4.14
Ads for effic. AC	20.52	3.34
Intercept	37.34	13.50
Adjusted R-Square	0.1286	

Table 5: % of Motors That Are High Efficiency or VSD

Variable	Parameter Estimate	T-Value
Motor rebate	12.98	1.55
Past participation	9.61	1.49
Audit	12.31	1.44
Ads for effic. or VSD	2.41	0.31
Intercept	27.08	8.09
Adjusted R-Square	0.0384	

Table 6: % of Fixtures Connected to Lighting Controls

Variable	Parameter Estimate	T-Value
Lighting control rebate	4.42	0.63
Past participation	4.47	1.82
Intercept	10.14	6.21
Adjusted R-Square	0.0040	

Table 7: % of Lamps That Are CFLs

Variable	Parameter Estimate	T-Value
CFL rebate	0.03	0.01
Past participation	6.10	2.13
Audit	0.35	0.12
Ads for effic. lighting	5.68	1.93
Intercept	8.92	3.67
Adjusted R-Square	0.0195	

Table 8: % of Lamps That Are Fluorescent

Variable	Parameter Estimate	T-Value
Fixture rebate	0.13	0.04
Lamp rebate	3.13	0.83
Lighting reduction rebate	8.91	1.89
Past participation	4.25	1.45
Audit	7.03	0.54
Ads for effic. lighting	0.83	0.13
Interaction of Rebates w/ Audits	-7.40	0.54
Interaction of Rebates w/ Ads	1.28	0.17
Intercept	76.80	39.46
Adjusted R-Square	0.0040	

We also recognize that asking for historical information in a telephone survey can present significant measurement error from the ability of individuals to correctly recall things that occurred years prior. Nonetheless, many of the models achieved statistically significant results for the coefficients of interest.

The magnitude of the effect (as measured by the parameter estimate) of prior efforts was compared to that for the rebate. This comparison provided us the adjustment factor for the free ridership estimates by end-use. These adjustment factors were applied on a participant basis based upon their individual reposes for these past program questions. The overall free ridership (naturally occurring savings) for an end-use is the kWh savings weighted average of the individual free ridership estimates. These MT adjustment factors are presented in Table 9.

Table 9: Free Ridership Adjustments for Market Transformation

	Past Participation	Audit	Ads
Fixture rebate	0	0	0
Lamp rebate	0	0	33%
Lighting reduction rebate	50%	25%	75%
CFL rebate	0	0	0
Ballasts	0	0	0
Lighting controls	0	0	0
AC & Chillers	50%	0	0
VSD	25%	0	80%
High Efficiency Motors	25%	0	80%

Table 10: Summary Table of Step-by-Step Free Ridership Factors (Step 4 Incorporates The Market Transformation Adjustment)

Measure	Step 1	Step 2	Step 3	Step 4
Lamps	30.3 %	20.5 %	16.4 %	0.6 %
Lighting reduction	35.2	23.8	20.7	9.1
CFLs	31.7	21.5	17.1	0.2
Fixtures	37.3	25.3	21.4	0.9
Ballasts	48.8	33.1	28.3	1.4
Lighting controls	55.4	20.4	21.9	0.5
AC & Chillers	62.4	33.4	31.4	17.1
VSD Motors	43.7	23.4	21.9	13.7
High Efficiency Motors	51.5	27.6	25.4	6.1

Free Ridership Results Net of Market Transformation

The market transformation effect was the fourth adjustment used in the overall free ridership study for Con Edison's C&I program. These four steps were:

1. Estimate a base free ridership estimate by measure from the customer survey-based method recommended by the Empire State Electric Energy Research Corporation (ESEERCO) Study, Stated Intentions with Consistency Check.
2. Calculate a Step 2 Adjustment by energy efficiency measure that approximates for the self-reporting bias difference between customer survey-based methods and nested logit methods of NOC estimation. This is based upon prior comparative studies from ESEERCO and Pacific Gas & Electric Company.
3. Create a Step 3 Adjustment from comparisons in installation rates and plans between participants, participants in the rebate process pipeline, non-participants who have participated in other programs, non-participants aware of the program, and non-participants unaware of the program.
4. Create a Step 4 Adjustment from survey responses to estimate self-reported free riders who actually were influenced by earlier Con Edison efforts, such as audits, advertisements, earlier program participation, and participation in residential programs by the decision-maker. This adjustment is to subtract those customers classified as free riders who were influenced by earlier utility actions, i.e., market transformation.

The results from these four steps are presented in Table 10. The Step 4 and final estimate by end-use presents the free ridership estimate net of market transformation. As you can see, there are large adjustments for market transformation, i.e., moving from Step 3 to Step 4. This means that prior utility program efforts (rebates, audits, and advertising) have a longer-term effect and create significant market transformation.

Most DSM programs may have some long-term MT effects. Further research as to what these have been could be quite useful and operate as a first step in determining how to measure MT effects for the next generation of MT/DSM programs being developed.

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