SOME ESTIMATES OF FREE RIDER PROPORTIONS IN DEMAND-SIDE MANAGEMENT PROGRAMS

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Introduction

In the context of a utility sponsored demand-side management (DSM) program, free riders are those participants who would have installed, on their own in the absence of the subsidy offered through the utility program, exactly the same energy conservation measures as those being promoted by the program. The energy savings attributable to free riders would be realized without the subsidy and should not be attributed to the utility program. Thus, when there are free riders among participants of a DSM program, including the energy savings of all participants in the cost benefit calculations would overstate the real benefit of the program. It is, therefore, important to estimate the extent of free rider participation in the program to properly conduct a cost-benefit analysis of a conservation or other DSM program.

There are few explicit estimates of free rider proportions. Morrison (1987) reviewed 70 studies of energy conservation program evaluations and found only eight specific estimates of free rider proportions. McRae et al. (1988) summarized 15 estimates for rebate programs, some of which were also included in the Morrison study.

This paper presents estimates of free rider proportions derived from evaluating experimental programs implemented by Illinois utilities during 1984-87. The results of 20 programs by nine utilities were reviewed and compared with available estimates from other sources. The programs are grouped into four program types: rebate, loan, lowincome targeted, and other audit programs. The utilities include Central Illinois Light Company (CILCO), Central Illinois Public Service Company (CIPS), Illinois Power Company (IP), Interstate Power Company (IPW), Iowa-Illinois Gas and Electric Company (IIGE), Northern Illinois Gas Company (NI-Gas), North Shore Gas Company (NS), Peoples Gas Light and Coke Company (Peoples) and Union Electric Company (UE).[1]

This paper first discusses some concepts of free riders and then briefly explains the approaches used by Illinois utilities to derive estimates of free rider proportions. Available Illinois estimates are then presented and discussed by program type. Estimates from other sources are cited for comparison with the Illinois results. Finally, findings are summarized. For more detail on the methodological aspects of the Illinois estimates, see Lui and Fang (1989).

Concepts of Free Riders

Suppose a utility offers a rebate of $100 to any customer who replaces an old furnace with a new highefficiency unit. The participants in such a program can be divided into three groups: pure free riders, incremental free riders, and non-free riders.

- **Pure free riders** are those participants who would have installed the same highefficiency furnace without program incentives.

- **Incremental free riders**[2] are those participants who, without the program, would have purchased new conventional models with relatively low efficiency ratings or intermediate models with efficiency levels higher than the basic models and lower than that being promoted by the utility program. For the incremental free riders, the utility rebate program induces them to upgrade the efficiency of the furnaces installed. As a result, the composition of efficiency levels of installed furnaces is changed. This has been termed "the compositional effect" of a utility program. Other customers may be induced to accelerate the replacement of existing furnaces by a year or two—the "acceleration effect" (Weinstein et al., 1987).

- **The non-free rider** participants are those who see actions in replacing the old furnace with the high-efficiency unit are entirely due to the utility program.

The distinction between incremental free riders and non-free riders is related, to some extent, to the types of DSM options involved. In a furnace rebate program, because of the essential necessity to have a furnace in working condition in cold regions, most of the participants who are not pure free riders may be more properly treated as incremental free riders. This is because most of the old furnaces replaced through a utility program may need to be replaced anyway. There are indications that the old furnaces replaced by participants in a furnace rebate

program are in the higher end of the equipments' useful lives. For example, analysis of the CILCO survey of participants in its furnace rebate program showed that the average age of the old furnaces (for the 100 participants who replaced their old regular gas furnaces) was about 25 years. Similarly, a survey of participants in the furnace rebate program operated by NI-Gas revealed that the average age of old furnaces replaced was about 22 years. Since the useful life of a gas furnace is in the range of 18-25 years, such information suggests that most of the old furnaces were in need of replacement when they were replaced. In contrast, in an insulation program, there may not be an absolute need for the homeowners to upgrade the insulation levels of their homes. Hence, those participants who are not free riders can be largely treated as non-free riders and the total insulation costs can be used in the cost-benefit analysis. Seen in this light, using the concept of incremental free riders can be regarded as another way of properly handling the incremental cost of a DSM program in cost-benefit calculations.

Approaches to Estimating Free Rider Proportions

The nine Illinois utilities included in this study used two approaches to estimate free rider proportions or effects: survey and controlled analysis of energy use. In the survey approach, questions concerning participants' potential behaviors in the absence of the utilitysponsored program were asked. Estimates of free rider ratios were then derived from responses to the questions. Utilities using this approach include CIPS, IP, NI-Gas, and IIGE. CILCO also used the survey approach to derive estimates for one of its four programs. The advantages of this approach include easy application and minimal additional cost when surveys on participants and control groups are already planned. However, this approach suffers from various biases associated with the survey instrument, the conduct of the survey, and interpretation of wording of the questions. There is also an inability to conduct independent verification of the results.

The second approach is to analyze the energy uses of control and participants groups using appropriate econometric procedures. In a program with a valid control group design, the ratio of net program-induced energy savings to gross energy savings per participant will indicate the extent of free ridership. In estimating net program-induced energy savings, it is necessary to control for differences in characteristics between participants and non-participants. If net program-induced energy savings is equal to gross energy savings per participant, the energy savings ratio of 1.0 implies zero free ridership because all energy savings is program induced. Con-

versely, an energy savings ratio of 0.0 would imply 100% free ridership because none of the energy savings are program induced. CILCO termed this approach "controlled analysis" and used it to estimate free rider proportions in three of its four programs. IPW used a version of this approach, without controlling for relevant factors.

In addition to the two approaches described above, Peoples and NS, through their consultant, reviewed available estimates in the literature to determine the potential range of free rider proportion for DSM programs. The actual proportions were dependent on the professional judgment of the researcher who conducted the review or the utilities' discretion. This approach does not yield independent estimates of the free rider ratio for specific programs.

Estimates of Free Rider Proportions

In presenting the estimates of free rider proportions, four program types are used: rebates, loans, low-income targeted, and other audit programs. In the following discussion, the methods used to estimate free rider proportions in the furnace rebate program are discussed in some detail. For the other program types, the approaches and prominent aspects are briefly noted. Where available, estimates of the same program type from other studies are noted for comparison.

Rebate Programs

Rebates were offered by Illinois utilities for high-efficiency gas furnaces, heat pumps, air conditioners and refrigerator-freezers. Since evaluations of some programs are not yet complete, this discussion is limited to rebate programs for gas furnaces and heat pumps. Peoples, NS, CILCO and NI-gas offered rebates for furnaces. CILCO and CIPS offered rebates for heat pumps.

High-efficiency Gas Furnaces. NI-Gas surveyed program participants to estimate the extent of free rider participation. Participants were asked the question, "How likely is it that you would have installed this new gas high-efficiency furnace/boiler if NI-Gas did not offer you the $100 credit?" Seventy-one percent of the respondents indicated "very likely" and are treated as pure riders. Eighteen percent responded with "somewhat likely" are treated as incremental free riders.

Based on participant survey responses,[3] CILCO estimated that between 40% and 60% of the participants in its furnace rebate program re free riders. The question asked in CILCO's survey is: "Would you say that the CILCO rebate had a great impact on you in your efforts to reduce your energy costs, a moderate impact, a slight impact, or no impact?" The proportions of responses were:

Great impact, 8%
Moderate impact, 35%
Slight impact, 17%
No impact, 41%

Including only those respondents who indicated "no impact" as free riders, the proportion is 41%. Enlarged to include those indicating "slight impact," the proportion of free riders would become 58%.

Morrison (1987), the consultant to Peoples and NS, determined through literature review that available estimates of free rider proportions ranged from 15% to 85%. The two utilities then "judgmentally" determined[4] that 42% of their customers participating in the rebate programs were pure free riders; that 53% were incremental free riders; and that the other 5% were not free riders.

It follows from the above discussion that the ratio of free riders in the four gas furnace/boiler rebate programs offered by Illinois ranged from 40% to 70%.

Heat Pumps. With respect to heat pumps, CILCO used the same approach used in the furnace rebate program and estimated the free rider effect as 40%. CIPS used a participant survey to estimate the proportions of free riders. One question included in the survey was:

Which of the following best describes the effect of the rebate upon your decision to purchase the heat pump? If CIPS had not offered the rebate...

(a)...I definitely would not have purchased the heat pump.
(b)...I probably would not have purchased the heat pump.
(c)...I probably would have purchased the heat pump anyway.
(d)...I definitely would have purchased the heat pump anyway.

By including all those who answered with response (d) and one-half of those who answered with response (c), CIPS estimated the free rider proportion to be about 60%.

Estimates from Other Studies. In a study conducted for the California Energy Commission, McRae *et al.* (1988, p. 9.80) found that free rider ratios in rebate programs ranged from 25% to 89% for refrigerators, 70% for furnace and air conditioner filters, 71% for water heaters, 50% for window shades, 33% for weatherization, heat pumps, and evaporative coolers, and 29% for water heater blankets.[5] McRae *et al.* recommended utilities to use free rider estimates in the range of two-thirds to three-quarters of program participation.

Loan Programs

NI-Gas implemented two loan programs: a ceiling insulation loan program and a high-efficiency gas furnace loan program. Using surveys of participants, it was

estimated that, in the ceiling insulation loan program, about 22% were pure free riders. Similarly, in the gas furnace rebate program, pure free riders were estimated to be 48% and incremental free riders, 22%.

CILCO employed the controlled analysis approach and estimated that free rider effect to be about 50%. CILCO also reported that the weighted average of survey responses regarding individual conservation actions yielded a free rider proportion of about 70%.

Peoples assumed zero level of free rider participation in its single family loan program. This assumption was based on the argument that the single family loan program targeted low- to medium-income customers. Peoples further assumed the free rider proportion in its multi-family loan program to be 15%, which was derived from a home energy audit program and the lowest estimate among those found in the literature review (Morrison, 1987).

In summary, excluding the estimates judgmentally derived by Peoples, the estimated free rider proportions as reported by Illinois utilities for loans on home insulation, weatherization and installation of energy efficient gas furnaces ranges from a low of 22% to a high of 70%.

For comparison, a study conducted by Illinois Department of Energy and Natural Resources on its Home Energy Loan Program (HELP) reported survey results that are within this range. When asked whether he/she would have taken the same energy conservation actions without the assistance from the program, 49% of participants responded that they would have taken exactly the same actions. Further, a second question asked: *"If you installed a new energy-efficient furnace as part of he HELP program do you think you would have installed the same furnace or a less expensive, less efficient furnace if the HELP program were not available?"* The responses indicated that 33% would have installed high efficiency furnaces and 29% would have installed less expensive, less efficient furnaces (Hall, 1988).

The difference in the results in the DENR study derived mainly from the coverage of energy conservation measures included. The 49% free rider proportion was for all the different measures installed by participants in the program. In contrast, the 33% estimate was specifically related to the furnace portion of the program. Hall also noted that, when there are low-income participants, the responses to questions such as the ones included in the DENR survey may not be valid indicators of free rider ratios because of potentially conflicting responses.

Low-income Weatherization Programs

Most of the programs targeting low-income customers involved a kit of weatherization materials distributed

free to eligible customers with or without installation help. A couple of the programs included extensive weatherization work on the houses of the low-income customers. Because low-income customers usually lack the financial means to fund improvement in energy efficiency, it can be expected that the proportion of free riders in such programs is generally lower in such programs than in rebate or loan programs. Estimates of free rider proportions in such low-income programs are given in Table 1.

Table 1. Free-ridership Estimates for Low-income Programs

Utility	Program	Free Rider Proportions
NI-Gas	Kitsd	14%
NI-Gas	Supplementary Grant	6
UE	Wrap Up	25
IP	Program 600	15
IP	Program 1500	10
CILCO	NEW	45
IPW	Low-income Audit	63-96

Excluding those derived by IPW, the estimates range from 6% for NI-Gas' Supplemental Low-income Weatherization Program to 45% in CILCO's Neighborhood Program. As expected, this range is lower than those of rebate and loan program. CILCO used the controlled analysis of energy use approach and derived the 45% free rider estimate. The ICC Staff used CILCO's participant survey results and estimated the corresponding value to be 40%. Other estimates derived from participant surveys are in the range of 10% to 25%. IPW's estimates of free rider ratio for its low-income audit program ranges from 63% to 96%.

Other Programs

Other estimates of free rider proportions are as follows: NI-Gas' Thermography program, 16%; NI-Gas' Commercial and Apartment Conservation Service (CACS) program, 12%; CILCO's Ener-Check Program, 61%. All three are audit programs for the commercial and apartment sectors. The results by NI-Gas are based on customer surveys with questions phrased in a similar manner as discussed in relation to its furnace rebate program. CILCO used the controlled analysis approach described above. For comparison, the ICC Staff used the CILCO survey results and identified the corresponding estimate as being 54%.

Findings

Table 2 presents a summary of the estimates discussed above. Due to various problems associated with their estimation, the Illinois results should be regarded only as first approximations of free rider ratios.[6] With this caution, the following findings can then be highlighted:

- Estimates of free rider proportions in high-efficiency gas furnace rebate programs operated by four Illinois utilities during 1984-87 are in the range of 40% to 71%. The corresponding estimate for heat pump rebate programs is 40% for CILCO and 60% for CIPS. These can be compared to the following estimates from rebate programs in other states: Wisconsin Power and Light's energy efficient refrigerator rebate program, 53% to 72%; New State Electric and Gas Corporation's refrigerator rebate program, 65% to 70% (Morrison, 1987).

- For the loan programs for home insulation, weatherizaton and installation of energy efficient gas furnaces, the estimates of free rider proportions ranged from 22% to 70%.

- Estimates of free rider proportions for low-income audit, kit, and weatherization programs are in the range between 6% and 45%. Thus, the results appear to confirm the expectation that, due to the nature of the programs and the characteristics of the participants, programs targeting low-income customers would tend to have smaller proportions of free riders.

- Estimates for audit programs for the commercial and apartment sectors ranged from 12% to 61%.

Endnotes

[1] The investigation of utility-sponsored conservation programs was initiated by the Illinois Commerce Commission (ICC) in 1983 and covered 10 major electric and gas utilities in the state. Commonwealth Edison Company (Edison), the largest electric utility in Illinois, has not completed implementation and evaluation of its programs. Hence, there is no estimate of free rider proportions from Edison's programs as yet. For a description of the scope of the investigation and individual programs, see Fang *et al.*, 1988.

[2] This term was used by Peoples, NS, and NI-Gas.

[3] This is in contrast to CILCO's preferred approach of controlled analysis of energy use. Note, however, that CILCO did use its preferred approach and derived a "compositional free rider effect" of 24%.

Table 2. Estimates of Free Rider Proportions in DSM Programs, by Program Type

Program Type/Name	Utility	State	Free Rider Proportion	Estimation Approach
Rebate Programs				
Gas Furnaces	CILCO	IL	40-60%	Survey
	NI-Gas	IL	71%	Survey
	Peoples	IL	42%	Literature Review
Heat Pump	CILCO	IL	40-60%	Survey
	CIPS	IL	60%	Survey
Refrigerators	NU, PG&E, CMP, NEES, WP&L, NYSEG SCE	CA, WI Northeast	25-89%	
Other Appliances	PG&E, CMP, SCE	CA Northeast	29-71%	
Loan Programs				
Ceiling insulation	Ni-Gas	IL	22%	Survey
Furnace	NI-Gas	IL	48%	Survey
Weatherization	CILCO	IL	50%	Controlled analysis
			70%	Survey
Single-family	Peoples	IL	0%	Judgemental
Multi-family	Peoples	IL	15%	Judgemental
Other weatherization	IDENR	IL	33-49%	Survey
Low-income Programs				
Weatherization kit	NI-Gas	IL	14%	Survey
Weatherization grant	NI-Gas	IL	6%	Survey
Wrap-up	UE	IL	25%	Judgemental
Program 600	IP	IL	10%	Survey
Program 1500	IP	IL	15%	Survey
NEW	CILCO	IL	45%	Controlled analysis
Home energy audit	IPW	IL	63-96%	Energy use analysis
Other Programs				
Thermography	NI-Gas	IL	16%	Survey
CACS	NI-Gas	IL	12%	Survey
Ener-check	CILCO	IL	61%	Controlled analysis
RCS	Connecticut	CT	15-20%	Survey
AC Control	PG&E	CA	36%	Direct estimate
	SMUD	CA	27-40%	Direct estimate
	SCE	CA	<15%	Direct estimate
"Energy Conservation Programs"	NU	Northeast	20-30%	Penetration rates

[4]In their respective reports, the two companies simply stated that these proportions are based on a recommendation from their outside consultant, RCF, Inc.

[5]Note that estimates in this study were expressed in terms of the ratio of net impacts to gross impacts. The free rider proportion, expressed as a ratio, is equal to 1.0 minus the net-to-gross ratio.

[6]The problems associated with these estimates are discussed in Lui and Fang (1989).

References

(Note: This reference list is abbreviated due to space limitation. For a complete listing and documentation, see Lui and Fang, 1989).

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