Innovativeness, Predisposition, and Freeridership

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Data from surveys administered as part of two separate studies of utility residential customers are used to test hypotheses derived from Rogers and Shoemaker's classic model of the diffusion process. In general, the data support the hypotheses. In addition, the data suggest that the characteristics of the products themselves are of vital importance in understanding the rate of diffusion. However, the data are equivocal regarding the identity of freeriders. In one case, the program induced participants are those most innovative and predisposed; in the other case, the freeriders are.

Introduction

Since the mid- 1980s, the electric utility industry has been asked by state regulatory agencies to promote the development and adoption of technologies and behaviors designed to reduce the energy necessary to perform specific end-use services. As investments in these utility conservation programs have grown, it has been argued that some end-use customers are "freeriders" —that is, they receive benefits for actions they would likely have taken regardless of utility program promotion efforts. In the interests of optimizing program performance for the benefit of stockholders and ratepayers, according to these critics, it behooves utilities to minimize the proportion of program participants who are freeriders. How then do we identify freeriders and design programs to minimize freeridership?

Social scientists have long been interested in innovations, the spread of new technologies and behaviors.[1] In their classic review of innovation diffusion research, Rogers and Shoemaker proposed that innovation diffusion rates are often normally distributed so that the cumulative frequency distribution forms an "S" shaped curve.[2] The authors also defined a set of adoption categories, ordered in the sequence of adoption and based on the individual's "innovativeness," defined as "the degree to which an individual is relatively earlier in adopting new ideas than other members of his social system."[3] The first group are "innovators," which the authors describe as "venturesome" and "eager to try new ideas."[4] The next group are "early adopters," and are described as more integrated members of society, that are "respected" and "role models."

Depending on an individual's "predispositions,"[5] innovativeness is likely to be selectively applied. These predispositions lead individuals "to expose themselves to those ideas which are in accord with their interests, needs or existing attitudes" and to "consciously or unconsciously avoid messages which are in conflict."[6]

Adoption rates also depend on the potential adopters' perceptions of an innovation's characteristics. Rogers and Shoemaker suggested that "from 49 to 87 percent of the variance in rate of adoption was explained" by five attributes: relative advantage, compatibility, complexity, trialability, and observability.[7] Based on a review of 75 studies, Tornatzky and Klein found evidence to support hypotheses of relationships between the rate of adoption and each of the first three characteristics, but less support for relationships with the last two.[8] Srivastava et al. have demonstrated the superiority of a multi-attribute model of the diffusion process as compared to a simple time-dependent or "naive" model.[9] Homer has applied to principles of systems dynamics to develop a flexible model of the diffusion of medical technologies.[10]

According to Rogers and Shoemaker, the adoption rate increases with increased relative advantage, increased compatibility, reduced complexity, increased observability, and increased trialability (or reduced risk).[11] Promotional programs, such as those sponsored by electric utilities, are intended to increase the adoption rate for new products or services by increasing the relative advantage (reduced costs, hence increased profits), by increasing the trialability (or reducing the risk, especially financially), by decreasing the complexity of the new product or service (for example, by providing installation services), and by increasing observability (for example, with the prominent yellow labels clearly presenting the average annual costs

of operation of various models of refrigerators). In short, the programs seek to accelerate the expected adoption date for as large a population segment as possible. The programs are deemed cost-effective if the costs associated with the energy saved by adjusting the adoption date are greater than the costs of the programs themselves.

However, interested observers argue that the utilities cannot take credit for all the purchases made under the program because some of those who participate would have purchased the product or service if the promotion had not been offered. These are the freeriders. To date, freeriders have been identified through the administration of a relatively straightforward question, from the evaluator's perspective: "In the absence of the program, would you have made the same purchase." But the question itself requires a complex thought process on the part of the customer. As a result, questions arise regarding the reliability of the answers. In addition, the identification can only occur after the purchase; there is no *a priori* way to identify potential freeriders. The inquiry reported here seeks to determine the extent to which data from recent evaluation studies support the Rogers and Shoemaker model. Second, to the extent the model is supported, we wish to determine the extent to which those identified as innovators and early adopters account for the freeriders identified using currently popular methods.

Based on Rogers and Shoemaker's model of the diffusion process, we propose the following hypotheses:

1. Other things equal, the older the program, the lower the proportion of innovators among the adopting population.

2. Other things equal, the older the program, the lower the proportion of adopters who are predisposed toward energy efficient products.

3. Other things equal, the greater the relative advantage and the more compatible, simpler, observable, and trialable the product, the lower the proportion of adopters who are innovators or who are predisposed toward efficient products.

4. Other things equal, the greater an individual's innovativeness, the more likely is the individual to portray themselves as willing to adopt an innovation in the absence of a promotional program.

5. Other things equal, the greater an individual's predisposition toward an innovation, the more likely is the individual to portray themselves as willing to adopt it in the absence of a promotional program.

The Studies

The paper reports the results from two studies of residential customers of two large electric utilities. We shall refer to the utilities as utility A and utility B. Both studies include samples of customers selected from utility records based on customer participation in utility rebate or discount sales programs. Both programs involve multiple products and, in both cases, samples of nonparticipants have also been selected.

The sample for utility A was comprised of 1,300 residential customers, including 200 nonparticipants and 1,100 customers who had participated in at least one rebate or discount sales program. The participant sample was stratified based on the product for which a rebate or discount was received and on the year the rebate or discount was provided. Seven product lines were included in the study:

- Shell weatherization measures
- Central air conditioning systems
- Central air conditioning system tune-ups
- Room air conditioners
- Refrigerators
- Light fixtures
- Compact fluorescent lamps

Three time periods were defined: 1987 to 1989, 1990 to 1991, and 1992. Rebates or discounts were not offered for two of the products during two of the time periods, resulting in a total of 19 participant strata. Nonparticipants were selected from among all customers who had not received a rebate or participated in a discount sale at their current address, but who had returned a recent utility mail survey.

The strata were not mutually exclusive. Some households may have received rebates for purchases of two or more products. In addition, a household may not have participated in the programs at their current address, but may have participated at a previous address. Thus, the sample does not represent a single stratified sample of customers, but a series of samples with replacement. We have attempted to control for these factors by including questions concerning the customers' recollections of product purchases and rebate receipt.

In some cases, the time periods for a given product line may be treated as several strata of a single population. That is, it is doubtful that a single household received rebates for the purchase of two central air conditioning systems over the six years covered by this study. For light fixtures, compact fluorescent lamps, and central air conditioning tune-ups, potential existed for multiple

participation within a given product line over the time the study covered. In these cases, the samples are not independent.

Each of the customers was selected with known probability, although the probabilities vary depending on the product line (stratum). For each product stratum, we obtained an estimate of the number of customers who had received a rebate or participated in a discount sale for each year the program was offered. Our analysis employs case weights that represent the inverse of these probabilities. The probability of selection for the nonparticipants was estimated as a ratio based on the estimated number of customers who have ever participated in a utility A program and the number of customers who returned a utility mail survey.

The second study involved four programs targeted at two groups of residential customers. Two programs—rebates for the purchase of efficient refrigerators and discounted purchases of power saver cords–were targeted at all residential customers.[12] A single sample of nonparticipant residential customers was also selected. Two programs targeted rural residential customers, one aimed particularly at residential customers who own livestock; these were rebates for the purchase of efficient yard lights and for the purchase of efficient livestock waterers. A separate sample of rural agricultural customer nonparticipants was also selected.

In this case, the programs were treated as entirely separate, and the samples as statistically independent selections from the utility customer pool. All of the programs were initially pilot efforts that the utility offered for three to seven months. Thus, no attempt was made to stratfy the samples by participation date. However, the samples were stratified by the customers' geographic locations to maximize the similarity between the participant and nonparticipant samples.

The Data

Both studies involved telephone surveys. Utility staff selected the customer samples, and the interviewers were provided with the names, addresses, and telephone numbers of specific customers. The utility A study employed a single instrument administered to all customers selected into the sample. Questions concerning program participation and likely behavior in the absence of the program were administered based on previous questions regarding customer purchases, not on the basis of selection stratification criteria.[13]

Early in the survey, customers were asked whether they had received a rebate for purchasing any of the eligible products. The survey proceeded to inquire about each of the various product lines. In each case, customers were asked whether they had purchased the product within the past five years and, if so, whether they recalled receiving a rebate for their purchase. If so, they were asked a series of questions intended to identify freeriders. The first question inquired when they had heard about the rebate—before, during, or after the shopping process. Customers were then asked whether, in the absence of the program, they would have purchased the product now or within the next six months, and whether they would have purchased a product of equal or less efficiency.

The study of utility B customers employed separate instruments for each program participant as well as separate instruments for each of the nonparticipant groups. The participant surveys began with an initial series of screening questions. Interviews with those who did not recall receiving a rebate or purchasing a product at a discounted price were terminated.

Among the questions administered to each of the participant groups for both utilities were a series asking whether the customer, in the absence of the program, would have purchased the product at the same time or at a later date and, when relevant, whether the customer would have purchased a product of the same efficiency.

Near the conclusion of all the surveys, customers were asked to agree or disagree with a series of statements using a five-point scale. Included in this series were:

- I am often the first in my neighborhood to try a new product or service.
- I am willing to pay up to 5% more for products that seek to reduce their impact on the environment.

Measures

We are primarily interested in the relationships between estimates of four measures: product purchase and program participation, innovativeness, predisposition, and freeridership. The operational definitions of the first measure are relatively straightforward. We rely on the customers' reports of product purchases and program participation—defined as receipt of rebate or discount purchase.

The logic employed in assigning customers a freeridership status is displayed in Figure 1. Customers who reported hearing of the rebate after the shopping process are considered freeriders. So are customers who said they knew of the rebate before making their final decision, but who would have made the same purchase at the same time regardless of the program. Those who would not have made the same purchase now but would have done so

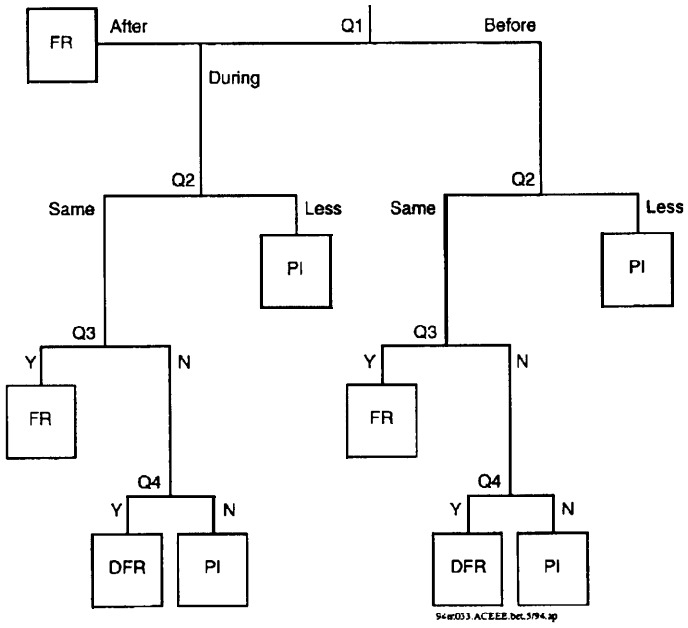
within the next six months are considered deferred freeriders. Those who said they would have purchased the product now but would have selected a less efficient model are considered full program-induced participants.

The measure of "innovativeness" is just those who say they like to be first in their neighborhood to do things. Those who said they would be willing to pay 5% more for environmentally sensitive products are considered "predisposed." Although we lack well-defined measures of the characteristics of the innovations, it does not seem unreasonable to infer at least ordinal values for certain characteristics. For example, of the products included here, shell weatherization measures appear to be the least trialable (highest cost), while compact fluorescent lamps and power saver cords appear to be the most trialable (least cost). However, due to difficulties associated with their installation, power saver cords may be more complex than many of the other measures. Similarly, problems associated with freezing may lend some additional complexity to cattle waterers, although the technology is relatively simple.

Results

About 97% of the weighted sample of utility A customers reported purchasing at least one of the eligible products during the last five years. Approximately 65% of the weighted sample recalled receiving a rebate or making a discounted purchase under an utility A program. Customers most frequently reported purchasing refrigerators (N_{est}=217,319), followed by compact fluorescent lamps (N_{est} = 174,493), and central air conditioning systems (N_{est} = 147,310). However, customers were more apt to report purchasing a CFL under the utility discount program (N_{est} = 129,707) than to report receiving a rebate for the purchase of an energy efficient refrigerator (N_{est} = 109,460).

Fewer than an estimated 15,000 customers reported installing shell weatherization measures, and only about 2,500 reported receiving an utility A rebate. Similarly, about 37,000 reported purchasing a new water heater, with only about 8,500 reporting that they received a rebate



PI = Program Induced
FR = Free Rider
DFR = Deferred Free Rider

Q1 = Did you know about the rebate before or after you thought about purchasing the (item)?
Q2 = If you had not received a rebate, would you have purchased a (item) of the same efficiency level or one that was less efficient?
Q3 = If you had not received a rebate, would you have purchased the (item) when you did
Q4 = If you had not received a rebate, would you have purchased the (item) within 6 months?

Figure 1. Freeridershlp Mapping

from utility A. In both cases, utility A's share of the market is limited by competing fuels.

Of the entire sample, including customers who may not have purchased any of the products or services, approximately 16% strongly agreed that they liked to be the first in the neighborhood to try a new product or service (Table 1). This approximately equals Rogers and Shoemaker's estimate of the combined proportion of innovators and early adopters.[14] Approximately 44% strongly agreed that they were willing to pay up to 5% more for products with reduced environmental impacts.

However, if we enlarge the scope of the categories by including all who at least agreed with the statement, nearly 30% of the sample could be considered innovators or early adopters, and nearly two-thirds could be considered predisposed toward purchasing products with reduced environmental impacts. The rates were essentially the same among those participating in at least one utility A program as with those who purchased but did not participate or did not make an eligible purchase at all.

For the remainder of this study, we propose to rely on this expanded definition for two reasons. First, under the more restrictive definition, the sample size becomes very small (fewer than five actual customers) in many cases. Second, the utility A sample is heavily biased toward program participants. Consequently, we would expect to find an excessive proportion of innovators and early adopters and customers who are predisposed toward the environment.

The rates varied, especially among the program participant groups, and, to a lesser extent, among those who purchased but did not participate (Table 2). As the CFL discount sale had been in operation the shortest period of time, the first hypothesis suggests that purchasers would be more apt to be innovators, compared to nonpurchasers and purchasers of other products. Indeed, the innovativeness rates were higher among CFL purchasers, regardless of whether they participated in the utility A discount purchase.

For the same reason, the second hypothesis suggests that purchasers of CFL's would be more predisposed toward protecting the environment. The data provide weak support for this hypothesis. Although both participant and nonparticipant purchasers were more apt to be predisposed compared to those who have not purchased CFL's, the proportions were less than for several other products.

The third hypothesis may explain some of the remaining variations among the programs and products. Shell weatherization measures are among the most expensive included (i.e., least trialable), and among the least observable once installed. Hence, one would expect the innovativeness and predisposition rates to be higher among those purchasing these measures. The proportions were indeed higher among the participants, particularly the program-induced participants. Though the proportions were not higher among those who purchased the measures without obtaining an utility A rebate, this may be confused by the utility's limited market share.

At the opposite end of the financial scale, light fixtures are comparatively inexpensive. In addition, though the fixtures are readily observable, the fixtures' energy efficiency may be less so, and there may be some question regarding the relative advantage of such fixtures. This appears to be confirmed by the proportions of innovators and environmentally predisposed customers among fixture purchasers. Although the light fixture program has been operating for as long as the other programs, the proportion of innovators was higher among purchasers of light fixtures regardless of whether they received a rebate. The rates were highest among those who said they would otherwise not have purchased an efficient fixture.

Table 1. Innovativeness and Predisposition by Product Purchased and Program Participation, Utility A

	Innovativeness			Predisposition		
Response	**All**	**Installed**	**Participant**	**All**	**Installed**	**Participant**
Strongly Disagree	22%	22%	18%	9%	8%	7%
Disagree	12%	12%	12%	5%	5%	5%
Neither	37%	37%	37%	20%	20%	20%
Agree	13%	13%	15%	22%	22%	22%
Strongly Agree	16%	16%	17%	44%	44%	46%

Table 2. Innovativeness and Predisposition by Product Purchased and Program Participation Status, Utility A

Particpnt Status	Shell Wx	WtrHtr	CAC Tune-up	RAC	CAC	Refrig	Light Fixture	CFL
Innovativeness - First in the neighborhood								
NonPrchs	29%	28%	29%	30%	28%	30%	25%	17%
Prchs w/o	29%	38%	33%	18%	26%	26%	51%	41%
Particip	61%	37%	24%	31%	31%	29%	54%	47%
Prg Inducd	76%	12%	24%	34%	59%	35%	81%	45%
Freerider	43%	40%	24%	29%	28%	27%	36%	56%
Predisposition - Willing to pay more for reduced impacts.								
NonPrchs	66%	65%	65%	66%	66%	69%	65%	61%
Prchs w/o	79%	67%	68%	63%	59%	62%	65%	72%
Particip	69%	86%	68%	81%	73%	64%	90%	72%
Prg Inducd	82%	89%	81%	95%	78%	62%	95%	72%
Freerider	59%	85%	66%	76%	73%	65%	85%	72%

Participants, particularly program-induced participants in the light fixture program, were also among the most likely to have said they were willing to pay more for products that reduce their impact on the environment.

Neither the fourth nor the fifth hypotheses appear to be supported by the data from utility A. In general, the proportions of innovative and predisposed customers were higher among the program-induced groups than among the freerider group or the freedrivers (those who purchased the product without a rebate). In some instances, there may be a question whether the product purchased outside the program was indeed energy efficiency (refrigerators, for example). In other instances, however, there is independent evidence that the market had shifted so that the only products available were energy efficient (central air conditioning equipment, for example).

Nevertheless, there are three instances in which the proportions of innovators among the freeriders or freedrivers were equal to or greater than the proportions among program-induced participants. These were for CFL's, new water heaters, and CAC tune-ups. In these cases, there is no question regarding the energy efficiency of the products or purchases made outside the program. While there may be some question regarding the relative advantage of CAC tune-ups and CFL's, both are comparatively trialable due to the relatively low cost of the product or service. In contrast, although a new water heater is relatively expensive, the relative advantage seems clear and well-documented.

The data for the utility Barograms also appear to support both the first and second hypotheses. Thus, using the broader definitions of innovativeness and predisposition, the proportions of innovators and predisposed customers are generally higher among the program participants than among nonparticipants. The single exception is the refrigerator program, where the proportions of innovators among participants and nonparticipants are comparatively low and about equal (Table 3). While all the programs were new, energy efficient refrigerators have been available for several years. Furthermore, neighboring utilities have sponsored programs to promote the purchase of efficient refrigerators. One of the utility's stated reasons for offering the program was to reduce the extent of "dumping''- the sale in utility B service territory of inefficient refrigerators that manufacturers were unable to sell in other utility service areas. Thus, the low proportions of innovators and predisposed customers among refrigerator program participants is consistent with the first two hypotheses.

Power saver cords have also been available for several years. However, customers apparently have difficulty installing the cords correctly, suggesting that the technology is comparatively complex. The higher proportions of innovators and predisposed customers among the participants in the power saver program is consistent with the third hypothesis.

In direct contrast to the results for utility A, the data for utility B appear to support the fourth and fifth hypotheses.

Table 3. Innovativeness and Predisposition by Product Purchased and Participation Status, Utility B

Participation Status	Power Saver	Refrigerator	Yardlights	Cattle Waterer
Innovativeness: First in the neighborhood.				
Nonparticipant	16%	16%	10%	10%
Participant	25%	16%	27%	19%
Program Induced	21%	0%	16%	28%
Freerider	32%	16%	27%	18%
Predisposed: Willing to pay more for reduced impact.				
Nonparticipant	62%	62%	56%	56%
Participant	70%	62%	73%	66%
Program Induced	62%	100%	69%	50%
Freerider	74%	61%	72%	68%

In general, the proportion of innovators and predisposed customers is higher among the self-reported freeriders than among the self-reported program-induced customers. The cattle waterer purchasers are a partial exception to this. The program-induced participants are more likely to be innovators, although the freeriders are more likely to be predisposed. However, questions exist regarding the relative advantage of the cattle waterers (due to freezing problems during the periods of coldest weather).

Conclusions

Data from studies of two separate utilities' demand-side management programs have supported hypotheses based on the diffusion process model described by Rogers and Shoemaker over 20 years ago. Thus, products and promotional efforts initially attract customers who are innovators and who are predisposed toward protection of the environment. Over time, the programs extend to customers who are neither innovators nor early adopters, and who may not be as predisposed toward protecting the environment.

The data appear to lend strong support for the critical importance of the characteristics of the products themselves. Products whose relative advantage is questionable, that are more complex, that are less observable, and that are less trialable are likely to penetrate the market more slowly than products that exhibit characteristics at the opposite end of the spectrum.

However, the data are equivocal regarding the relationship between innovativeness and predisposition, on the one hand, and freeridership on the other. Among the utility A customers, the self-reported freeriders are less apt to portray themselves as either innovators or as predisposed toward environmental protection than are the program-induced participants. In contrast, the utility B self-reported freeriders are most apt to also portray themselves as innovators and as environmentally predisposed.

There may be a sound explanation for this inconsistency. For example, utility A had offered its programs for approximately five years, while this was the first year in which DSM programs were offered by utility B. Nevertheless, this should not affect the relationship between innovativeness, predisposition, and self-reported freeridership.

Since the model proposed by Rogers and Shoemaker was otherwise confirmed in both studies, we conclude that the problem lies with the way freeriders have been identified for the purposes of evaluation. Speculating concerning one's behavior under hypothesized conditions is an unreliable procedure, at best. In addition, this approach can only be used *post facto.*

Freeridership is itself a somewhat illusive notion. If it is interpreted literally, then one might question the entire rationale for utility DSM programs. That is, viewed from sufficient distance, all of those who adopt the measures would likely have adopted them at some time.[15] The point of the program is to accelerate the adoption rate and move the adoption time sufficiently far forward that the cost of the energy saved is greater than the cost of the program.

Perhaps a more appropriate approach would be to model the dynamics of the energy efficiency measure adoption process, as Homer has done for medical technologies.[16]

The model may vary slightly depending on the specific technologies, or class of technologies involved. In the end, however, this will improve our understanding of the factors and processes involved in accelerating and dampening the diffusion of energy efficiency technologies. The model will likely also provide insight regarding when a measure has become "socially adopted. " That is, the point at which the measure is sufficiently diffused that further promotional efforts are unnecessary to continue the diffusion of the measure.

Endnotes

1. See for example the discussion in H. Lionberger. 1960. *Adoption of New Ideas and Practices.* Ames, Iowa. The Iowa State University Press, and in E.M. Rogers. 1962. *Diffusion of Innovations.* New York: The Free Press. The former provides a review of the intensive diffusion research on farm practices that was published in the 1940's and 1950's. The latter provides a comprehensive review of a number of different avenues of diffusion research to the publication date. Rogers' initial review was superseded by a somewhat more thorough review accompanying a more extensive theoretical discussion co-authored with Shoemaker: 1971. *Communication of Innovations*, 2nd Ed. New York: The Free Press. As recently as 1982, Sawyer relied on Rogers and Shoemaker's model in a study of solar owners ("Leaders in Change: Solar Energy Owners and Implications for Future Adoption Rates," *Technological Forecasting and Social Change* V.21(1982)201-211).

2. Rogers, Everett M. & F. Floyd Shoemaker. 1971. *Communication of Innovations*, 2nd Ed. New York: The Free Press. 177. Subsequent research suggests the normal model is only one of a family of curves that describe the diffusion process. See, for example, C.H. Skiadas, "Innovation Diffusion Models Expressing Asymmetry and/or Positively or Negatively Influencing Forces," *Technological Forecasting and Social Change* 30(1986)3 *13-356.*

3. Rogers and Shoemaker. 180.

4. Ibid. 183.

5. Ibid. 105.

6. Ibid. 105.

7. Ibid. 138.

8. Tornatzky, I.G. & R.J. Klein. 1982. "Innovation Characteristics and Innovation Adoption-Implementation: A Meta-Analysis of Findings," *IEEE Transactions on Engineering Management.* 28-45.

9. Srivastava, R. K., V. Mahajan, S.N. Ramaswami, & J. Cherian. 1985. "A Multi-Attribute Diffusion Model for Forecasting the Adoption of Investment Alternatives for Consumers, *Technological Forecasting and Social Change* 325-333. Although the subject is quite different—financial investment opportunities—the principle remains: i.e., innovation diffusion is a product of multiple factors interacting over time.

10. Homer, J.B. 1987. "A Diffusion Model with Applications to Evolving Medical Technologies," *Technological Forecasting and Social Change* 197-218

11. Rogers and Shoemaker. 138 ff.

12. This utility is located in a northern climate where winter temperatures are sufficiently low that engine blocks tend to freeze at night. Many customers place a warming device in the engine compartment. Rather than supplying power whenever plugged in, a power saver cord includes a thermostat that monitors the temperature and automatically shuts off power when the temperature in the engine compartment exceeds a pre-set level.

13. As a result of this approach, there are some interesting relationships between customer recollections and utility records, perhaps worthy of a separate paper.

14. Ibid. 182.

15. In 1975, Fishbein & Aizen reported on the relationship between attitudes, beliefs, intention and behavior. Their work demonstrated that the best predictor of behavior change is intention when compared to beliefs, attitudes, and opinions. Fishbein, M., & Aizen, I. (1975) *Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research.* Reading, MA: Addison-Wesley.

16. Homer, J.B. 1987.