Estimating Market Transformation Effects of Informational Programs

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ABSTRACT

Market effects attributable to informational programs are the difference between the extent to which the identified market barriers would have prevailed if the program had not been offered and the extent to which market barriers exist with the program in place. To help distinguish informational program-induced changes in customers' perceptions of market barriers from what would have naturally happened, discrete choice models are used to stimulate market barrier perceptions with and without exposure to the programs. Essentially, the market barriers perceived by exposed customers are compared with a comparison group, correcting for the simultaneity of the exposure and market barrier perceptions. Variance of the estimates can be approximated.

Introduction

The paper presents a quantitative technique to estimate the effect of informational programs on the market, in terms of the changes in the characteristics of the market. The technique is applied to evaluate effects of Pacific Gas & Electric's (PG&E) Agricultural Energy Management Services (AEMS) program on the markets for energy efficient water pumping equipment and services. The paper is based on the 'market transformation' model presented by Eto, Prahl and Schlegal, (1996) and some of the terms used in this paper should be interpreted as they are defined in Eto et al study[1]. Though it is true that measuring market effects in terms of kWh reliably is too complicated, the paper demonstrates that it is possible to find out the extent to which the intervention has reduced the severity of the market barriers in percentage terms. The analysis attempts to estimate the effects that may have occurred due to the program, using billing data and survey data for program participants and a comparison group.

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[1] The two terms frequently used in this paper and defined by Eto et al. are:
Market barrier: any characteristic of the market for an energy related product, service, or practice that helps to explain the gap between the actual level of investment in or practice of energy efficiency and an increased level that would appear to be cost beneficial.
Market effect: a change in the structure of a market or the behavior of participants in a market that is reflective of an increase in the adoption of energy-efficient products, services, or practices and is causally related to market intervention.

Background

As part of AEMS program, PG&E offers pump test services at no cost to customers since 1923. It was originally designed as a marketing and customer assistance program and later recognized as an information program to help promote energy efficiency for the water pump market. Therefore there are no specific objectives in terms of how and to what extent the program is expected to affect the market. After understanding different aspects of the program, and the current market condition, market barriers are identified.

Program Features

A pump test compares, the relationship between energy consumed and water flow at a given pumping pressure. After assessing the overall plant efficiency and only if replacement or upgrading of equipment is warranted, the customer is issued a cost analysis letter, which includes estimates of capital and operating cost impacts for a new system. After getting feedback from PG&E's service representative, it is at the customer's discretion to get the pump repaired or not. A pump repair can be expensive; therefore, a pump repair is advised only if the predicted long-term benefits from getting the pump repair outweighs the cost of the repair.

The program is delivered on demand - i.e., customers request a pump test from PG&E. There is no effort to recruit customers for pump testing. There are two aspects of the program. One, it provides information regarding energy efficient technologies via pump test services. This directly or indirectly develops motivation amongst customers to know about efficient technologies. Two, it gives participants knowledge about the efficiency of their pump(s) without any cost to the customer and informs the customer regarding possible long-term benefits of a pump repair.

These two aspects, while complimentary, are different with respect to the duration of the effects. The first one is educational and can possibly change the level of motivation permanently. For example, exposure to the program may direct the customer towards thinking and seeking information about efficient technologies in general. The second one, though educational, cannot be considered permanent. For example, since PG&E gives the information about efficiency of the pump at one point in time, the cost to obtain the information is zero only at that time. Whereas, the customer needs to assess the efficiency of their pumps periodically. Though the customer may be convinced of the importance of knowing the efficiency of the pumps as a result of the program, the information cost of finding the efficiency is not zero unless the customer participates in the pump test program again. Though the program was not designed to permanently 'transform' markets for energy efficient technologies, there is some interest in assessing the program's suitability to serve as a vehicle for future market interventions.

Market Conditions

The current market conditions need to be thoroughly understood to better ascertain possible market effects due to the AEMS program. In order to make an accurate determination as to whether it is cost effective to improve the pump efficiency or not, a pump test is a must. There is no alternative technique known. Thus, pump tests are inevitable if a customer is interested in implementing cost-effective efficient technologies. However, the pump test itself is expensive (unless a customer is participating in the AEMS program), and a pump repair to improve efficiency is even more expensive.

In the current market, a customer can choose one of three agencies to get a pump tested. These are (1) participation in PG&E's AEMS program, (2) pump test by an independent pump tester, and (3) dealer/distributor. Participation in PG&E's AEMS program is offered to all at no cost to customers. Though anyone can get a pump tested by a pump dealer, the cost can range between $150-$250. Some pump dealers/distributors offer pump test services only to their customers. Since the pump dealers/distributors also offer services for a pump repair, they may have a vested interest in the results of the test.

Besides the cost, the timing for a pump test is equally important. A pump test can be done only when the pump is running. Since PG&E gets many requests for pump tests, sometimes customers have to wait to get a pump tested. If the wait is too long or the timing is not suitable to the customer, depending upon the crop and when the pump is used, the customer may have to pursue other alternatives to get a pump tested.

Identification of 'Market Barriers'

After understanding the program features and current market condition, five market barriers that could have been affected by the program are identified for this analysis. The data collection instruments were targeted towards gathering the information to determine if these market barriers exist.

Motivation. Only if customers are aware of and interested in energy efficient technologies, are they likely to seek information regarding energy efficient technologies. In a market, if customers are not interested in seeking information regarding new equipment and/or efficient technologies, then it can become a barrier to adoption of new equipment and/or efficient technologies. Since PG&E's AEMS program provides information regarding energy efficient technologies via a pump test, the program can be considered to be instrumental in developing the motivation. Whether the program actually increased the level of motivation or not is the first hypothesis tested in this analysis.

Importance of knowing pump efficiency. If customers consider the knowledge of pump efficiency important, they are more likely to seek information regarding efficient technologies. It is possible that the high information and search cost may discourage the customers from considering efficient technologies as an option. If the AEMS pump test program has successfully changed the market, then customers would be convinced of the importance of awareness regarding pump efficiency. Whether PG&E's AEMS pump program has successfully made the customers realize the importance of knowing pump efficiency or not is the second hypothesis tested in this analysis.

Performance Uncertainty. One of the factors that may discourage customers from getting the pump tested and/or repaired is not believing in the predicted energy savings. The pump test encourages customers to know whether a pump repair would help them save energy or not. Initially, customers may not believe savings from a pump repair predicted via a pump test, but after their experience with PG&E, they may develop confidence in the pump test results and recommendations. Whether PG&E has been able to make customers feel more certain about the energy savings from the pump repair or not is the third hypothesis tested in the analysis.

Asymmetric Information. Another related factor that may discourage customers from getting the pumps tested and repaired is the source of information. If a particular agency is also involved in repairing the pump along with pump testing, then customers may think that the agency has an incentive to provide misleading information. Since customers perceive that PG&E as an independent institution does not have any incentive in misleading them, PG&E may be responsible for increasing the level of confidence in the predicted savings by providing customers an independent estimate of energy savings

via pump tests under the AEMS program. Whether the AEMS program made customers feel confident about information from other sources is the fourth hypothesis tested in the analysis.

Bounded Rationality. It is possible that even if customers are highly motivated and are convinced of the importance of knowing pumps' efficiency, they are not willing to take the necessary steps to improve the efficiency. The behavior of an individual during the decision making process that may seem inconsistent with the individual's goals is described as bounded rationality by Eto et al. This study looks into whether PG&E's AEMS program has helped to reduce such inconsistency.

Scope of the Study

There are two different services offered under PG&E's AEMS program. One, an audit of the whole facility and two, a pump test. Since the number of participants of pump test program is 25 times greater than the number of participants in the audit program, this analysis is focused on the second service, i.e., a pump test service of the program. The analysis focuses on analyzing behavior of only agricultural customers as market players since, they are directly affected by the AEMS pump test program. Thus, this analysis focuses on analyzing effects of the AEMS pump test program on the demand side of the market.

Market transformation is defined by Eto et. al. as reduction in market barriers due to a market intervention, that lasts after intervention has been withdrawn, reduced or changed. Since in this study, the reduction in market barriers attributable to the programs is observed only for one type, we think that this study attempts to estimate market effects rather than market transformation effects.

Methodology

After identifying potential market barriers, it is important to establish a causal link between program participation and changes in the market barriers (if any) in order to find out the extent to which these barriers were affected by the program. This consists of finding reduction (if any) in the level of above mentioned five hypothesized market barriers, and testing whether the reduction is a result of the program or not. In this study, customers' perceptions are used to indicate the level of each of the market barriers. In order to evaluate the market effects of PG&E's AEMS pump test program, each of the five market barriers is analyzed. The extent to which the AEMS pump test program affected each of these barriers is measured.

Issues Surrounding Evaluation of Market Transformation of DSM Programs

It is desirable to evaluate overall market effects of all DSM programs in one service territory. The following features forced us to evaluate program-specific, equipment type-specific, and market barrier-specific market effects of the AEMS program.

Importance of evaluating program-specific market effects. Since a combination of DSM programs affects the market, it is desirable to study the overall effects of DSM programs in a particular territory. However, such overall evaluation of market effects is difficult due to the unique program design and implementation.

Importance of evaluating equipment-specific market effects attributable to a DSM program. If a given program (intervention) offers information regarding more than one equipment type, it does not necessarily affect the market for each equipment type to the same extent. For example, some customers

may have been convinced about the performance of a pump repair more than other equipment types. Thus, the market effects attributable to a single program can be different for different equipment types.

Importance of evaluating market effects in terms of each market barrier. The extent to which a market barrier is perceived to exist may differ from one barrier to another. For a given equipment type (e.g., pump repair) the perceived existence of one market barrier (e.g., lack of motivation) may be lower than the perceived existence of another market barrier (e.g., performance uncertainty). Thus, the market effects can be different in terms of reduction in each of the identified market barriers. The disadvantage is that different market barriers may appear to be independent from one another and, in reality, they may not be.

Importance of assuming that customers face the market barrier to the same extent. This assumption is necessary since the differences in the extent to which the market barrier prevails for each customer is unknown.

Discrete Choice Analysis (DCA)

For estimation purposes, market effects attributable to a DSM program can be defined as the difference between the extent to which the identified market barriers would have prevailed if the program had not been offered and the extent to which market barriers exist with the program in place. For any given market barrier, the extent to which that barrier exists or not can be determined by selecting an appropriate indicator. We believe that the perception of market actors regarding the extent to which a market barrier exists is an appropriate indicator.

Since customers' perceptions regarding market barriers in absence of the program are not observed, it is necessary to compare the perceptions of exposed customers (to the AEMS program) with that of a comparison group. The participants' perceptions regarding market barriers may be driven by their participation in the AEMS program. In order to separate the program effects on the market barriers from other effects (e.g., due to changes in the market independent of the program), a comparison group's perception of market barriers needs to be included. Preferably, such a comparison group should not have been exposed to the AEMS program at all. However, there are two practical problems with identifying this type of population. First, identification of a 'similar' region without a program is difficult and imperfect. Second, once the area is identified, obtaining contact information is very difficult (if not impossible). Therefore, a comparison group is randomly selected from those PG&E agricultural customers who did not participate in the AEMS program during the past 3 years.

The quantitative method of analysis presented in this paper (called discrete choice analysis or DCA) is based on a simultaneous equations system, which Train (1994) originally proposed for free ridership. In Parikh, Kandel & Brown (1995), it was applied to estimate indirect effects of an electric utility's conservation education efforts.

Essentially, the analysis tries to answer the question; to what extent did the program (intervention) change the market. The change in the market can be approximated by the changes in the market barriers. If customers perceive that particular market barrier is not a barrier, then the question is: Did program exposure make the customer think that way, or, even without the program, would the customer have perceived a market barrier not as a barrier? In order to observe the program effects on the market barriers as perceived by the customers, a system of equations is required that explains the effects of various factors on the customers' perceptions of market barriers. It is important to recognize that, customers' decisions to participate in the program are partially dependent upon their perception of market barriers and their perceptions of market barriers are at least partially dependent upon their

program participation. This analysis untangles the pattern of causation between exposure to the program via participation and perceptions of market barriers. Each market barrier is modeled separately and assumed to be independent of one another.

One of the advantage of this approach is that it requires information on customer characteristics and the factors that affect their perception of market barriers for a sample of participants and a comparison group within PG&E's service territory. The second advantage is that it demonstrates a way of quantifying market effects in terms of percentages, i.e., to what extent the program has been able to reduce possible market barriers.

Modeling System

A customer's decision to participate in the program or not is expected to depend, at least partially, on the customer's perception of the market barrier. For example, if the customer does not consider efficient equipment for adoption, simply because he is not convinced of its possible advantages, the customer may participate in the program to find out about the equipment and its possible advantages. The customer also may have a preconceived idea about what stops him from adopting the measure (i.e., perception of the market barrier). This perception of the market barrier is in turn affected by the participation status of the customer. For example, exposure to the program via participation may bring awareness about the advantages of the equipment and the lack of awareness no longer discourages the customer from considering the equipment for adoption. Thus, the perception of market barriers and exposure to the program are interrelated. The relationship between participation and the perception of market barriers is represented in Figure 1.

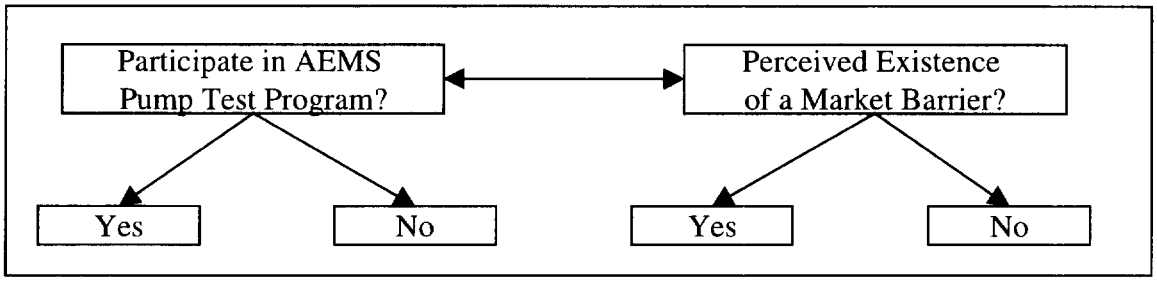

Figure 1. Relationship between Program Participation and Perception of Market Barrier

A set of two standard logit models, one for participation and the other for perception of a market barrier are estimated to evaluate the extent to which the AEMS pump test program reduced the market barrier. The customer's probability of participating in the program (i.e., obtaining a pump test) is described by a logit function, which has the following form:

$$Ppi = \left(\frac{e^{\beta Zi}}{\left(1 + e^{\beta Zi}\right)} \right)$$ Where Ppi (p=1) = the probability that the customer participates, Z = a vector of customer characteristics that relate to the customer's decision to participate, and β = a vector of parameters indicating how the characteristics Z relate to participation. This model is estimated by standard logit routines for example, the Logistic Procedure in SAS. It is expected that the decision to participate in the program is related to the customer's perception of a market barrier.

The customer has a perception about whether a particular market barrier exists or not. For example, a customer may be certain that, if recommended after a pump test, a pump repair will yield

energy savings. In such a case, performance uncertainty may not be a barrier for that customer. Thus, the perceived existence or non-existence of a market barrier can also be binary discrete choice that can be represented by a logit model. It takes the form:

$$Pbi = \left(\frac{e^{(\alpha Xi + \delta Di)}}{\left(1 + e^{(\alpha Xi + \delta Di)}\right)} \right)$$ Where Pbi (b=0) = the probability that the customer perceives the market barrier as not a barrier, X = a list of characteristics of the customer and features of the measure that affect perception of a particular market barrier, and D = a dummy variable that identifies whether the customer participated in the program. The program effect is captured by δ, the coefficient of participation dummy. This coefficient reflects the extent to which the program increased the customer's probability of perceiving the market barrier not as a barrier. Estimation of this model is complicated by the fact that the critical explanatory variable, the participation dummy D, depends upon the customer's perception of the market barrier. Since the customer's perception of a market barrier affects the customer's decision to participate, causation in this case also runs from the dependent variable to the participation dummy.

Such bi-directionality of causation is dealt with a substitution procedure as used by Hartman (1988) and Train (1994). In this procedure, along with other explanatory variables, the probability of participation instead of the participation dummy, is included as one of the explanatory variables. Technically, in a nonlinear model, replacing the participation dummy with the probability of participation does not provide a consistent estimate of the coefficient but the inconsistency is small. The final logit model then takes the following form;

$$Pbi = \left(\frac{e^{(\alpha Xi + \delta prob(Di))}}{\left(1 + e^{(\alpha Xi + \delta prob(Di))}\right)} \right)$$ Where δ still captures the effect of the program and prob(Di) is the probability of participation for the ith customer. The market effect of the program in terms of one market barrier is determined by estimating the effect that would occur with the programs in place and the effect without the programs in place, and then comparing the two.

Sources of Data

PG&E program design documentation was used to understand the program features and market condition before identifying the market barriers. The program databases for the years 1994, 1995, and 1996 and the billing data for the years 1994, 1995, and 1996 were used for selecting the sample for additional data collection and for observing customer characteristics to be included in the model. Additional information was collected via a telephone survey for a sample of 200 participants and 202 customers from a comparison group. The survey instrument was designed keeping in mind the identified market barriers. Thus, a total of 402 customers were included in the estimation of the two models described above.

Results

To estimate the market effect attributable to the AEMS pump test program, six logit models were estimated, a participation model and five market barrier models; one for each of the five market barriers. (1) First, probability of participation (defined as binary) was estimated for each customer using the results of participation model. (2) Second, probability of perceived non-existence of market

barrier (defined as binary) with the program in place was estimated using the results of each market barrier model. (3) Third, the overall market effect was calculated as the product of these two probabilities. For example, the model results of participation model and one of the market barriers are presented in Exhibit 3 and 4 and 3. (4) Fourth, the probability that a customer does not consider a market barrier as a barrier in the absence of the AEMS pump test program was simulated. This was done by assuming the participation dummy (or to be precise, the probability of participation) as an explanatory variable as zero for each market barrier. (5) Fifth, *the market effect attributable to the program* was calculated as the difference between what would have been the perception of a market barrier with the program in place (done in (3)) and without the program in place (done in (4)). The estimated effects using the model results and the confidence interval around them are presented in Table 1. The market effects estimates presented are conservative since it only accounts for the effects on the participants.

Table 1. Market Effects Attributable to the AEMS Pump Test Program

Market Barrier – Responses by Customers	Current Market Condition	Percent of the Current Market due to AEMS Program	90% Confidence Interval
1: Motivation	49%	34%	5%-37%
2: Importance of Knowing Pump Efficiency	72%	23%	5%-20%
3: Performance Uncertainty	79%	15%	0.7%-16%
4: Asymmetric Information	76%	Unable to Determine	-
5: Bounded Rationality	51%	(-24%)	(-30%)-(-9%)

In order to make use of the market effects attributable to the AEMS pump test program in an informed manner, one must also have at least approximate knowledge of the uncertainty associated with the estimated ratios. Estimation of uncertainty is complicated by the fact that the functional relationship between the market effects and the model coefficients is nonlinear. For this study, a confidence interval around the effect is estimated using one of the explanatory variables. The method involves taking the standard error of the estimated coefficient of the most important variable in all five models for each market barrier, then calculating the maximum and minimum market effects at 90% significance level. The estimated coefficient and the standard error of the probability of the participation variable was used because the probability of participation is a function of all the variables in the participation model, and its parameter is estimated in the market barrier model.

Motivation - Efficiency In General

In the initial stages of introducing an efficiency concept, it is important to motivate customers to take interest in finding out more about the efficient technologies/practices. Since the inception of PG&E pump testing in 1923, customers have experienced electricity price increases and vast improvements in the speed at which information travels within the marketplace. From the survey responses it is observed that 49% (195 out of 400) of the agricultural customers are 'very interested' in acquiring information about efficient equipment or the latest technology and 38% of the agricultural customers are 'somewhat interested' in acquiring information about efficient equipment or the latest

technology. Together, 86% of the agricultural customers are at least somewhat motivated to learn about efficient technologies at The hypothesis of whether those 86% will continue to be motivated in the future or not was also examined. It was found that 99% of 86% think that they will continue to be motivated in the future. This indicates that in the market for efficient technologies/practices for agricultural customers, motivation has improved and will remain improved in the future.

The next question is how much of the observed motivation is attributable to the program. Of the 195 motivated customers (who responded to be 'very interested'), 112 are participants. The DCA indicates that 34% of the motivation observed among participant agricultural customers (38 of the 112 motivated participants) is attributable to PG&E's AEMS pump test program. If spillover effect of the program is assumed to be zero, then 19% of the motivation (38 of 195 customers) is a result of the program. Approximately eight out of ten motivated customers are motivated not as a result of the pump test program but are most likely motivated due to other factors, such as high electricity prices or by communication with other growers. It is possible that customers' current perceptions could well be under allocating credit for the long-term effects of the presence of the program. The confidence interval indicates that, at least one customer and maximum of 4 customers out of ten motivated customers are motivated as a result of the program. We think that unless future program efforts focus on those customers who are not motivated, the program effect on motivation may decrease.

Importance of Knowing Pump Efficiency

In the initial stages of product introduction, it is important to make customers take interest in finding out more about the new product. In this case, when the program started, pump tests as a tool to learn about pump efficiency may have been a new product and getting customers to take an interest in knowing the efficiency of their pumps may have been a challenge. However, the program has been offered for many years and customers may have already realized the value of knowing the efficiency of their pumps. This could be the result of experiences such as crop loss due to insufficient water supply or a pump breakdown. From the survey responses it is observed that 72% of the agricultural customers consider that knowledge of pump efficiency is 'very important' and 23% consider that knowledge of pump efficiency is 'somewhat important'. Together, 95% of the agricultural customers are at least somewhat interested in knowing the efficiency of their pumps. This indicates that in the market for pump tests (i.e., a tool to know pump efficiency), most customers are interested to some extent in knowing the efficiency of their pumps.

The DCA indicates that 23% (36 customers out of 157 participants) are interested due to the program. If the spillover effects of the program are assumed to be zero, 13% (36 out of 288) of total interested customers are taking an interest as a result of the program. The remaining consider the knowledge about pump efficiency important probably due to their own experiences or experience passed on from their mentors or peers. The confidence interval indicates that, maximum of 2 out of ten customers take interest in pump efficiency as a result of the program. The survey responses indicate that the interest in knowing pump efficiency among customers is quite high and DCA indicates that the effect attributable to the program is low. It is important to remember that the DCA based on current customer perception cannot account for indirect long-term influences that may have resulted from the existence of PG&E's program.

Performance Uncertainty - Certainty About Benefits Projected by a Pump Test

In the intermediate phase, of product introduction, when presumably, the customers are motivated and interested in knowing specific efficiency levels, unless the customers are certain about the usefulness of pump test as a tool, they may not be interested in using the tool. In the survey the question regarding certainty about benefits projected by a pump test was asked of those who had at least one experience with pump test. Out of a total of 402 customers interviewed, 338 had at least one experience with a pump test. From the survey responses it is observed that 79% (267 of 338 respondents) of agricultural customers believed in the benefits of a pump repair as projected by a pump test. 82% (219 of 267) of these particular customers are sure that they would continue to believe in projected benefits in the future. Thus, a fairly large proportion of customers believed in the savings projected by a pump test at present and will continue to believe in the future.

The relevant question is how much of the perceived certainty in the savings projected by a pump test is attributable to the program. The DCA indicates that 15% of the participants who perceive themselves to be certain of the pump test results are certain as a result of the PG&E's AEMS pump test program. If the effect of the program is assumed to be only of the participants, then 9% became certain due to their participation in PG&E's AEMS pump test program. Out of ten customers who believe in pump test results, 9 customers believe in pump test results for other reasons. The confidence interval indicates that, out ten customers, maximum of two customers are certain about pump test results as a result of the program. The survey responses indicate that the perceived certainty regarding pump test results is quite high, indicating that the performance uncertainty market barrier is low. The DCA indicates that the program contribution to the performance certainty is low. It is important to remember that the DCA based on current customer perception cannot account for indirect long-term influences that may have resulted from the existence of PG&E's program.

Asymmetric Information - Level of Confidence in Pump Test Results If Not Done By PG&E

The hypothesis tested for this barrier is whether or not the AEMS program educated the customers to the point where they feel confident about information from sources other than PG&E. Though all agencies may be capable of providing technically reliable estimates of pump efficiency, customers may perceive that some agencies are more likely to be biased than others.

Out of a total of 402 customers interviewed, 370 customers responded to the question regarding how confident they would be in pump test results if it were done by pump dealers or an independent pump tester, if PG&E were not offering a pump test at no cost to customers. The responses indicate that 76% would trust either a pump dealer or an independent pump tester as much or more than they trust PG&E now. The finding suggests that while PG&E is perceived to be professionally unbiased (by customers), customers are also confident about pump test results that they receive from agencies other than PG&E.

The DCA could not determine the effect of the program with any confidence. Since the factors that influence the confidence about pump test results if it were done by PG&E, pump dealers or independent tester are not definite or clear, it was difficult to separate the effects of these other factors from the program effects. However, what appears clear is that asymmetric information with respect to who supplies the pump test does not appear to be a significant market barrier in terms of customer's confidence in the results of pump tests.

Bounded Rationality

If agricultural customers realize the value of the information provided via a pump test, would they be willing to pay for a pump test to get that information? In this analysis, if they both believed in the value of a pump test and would be willing to pay for it, the customer was considered 'rational'. The survey responses indicate that 51% (204 of 400) are 'rational'. Out of the 204 'rational' customers, 135 consider the information from a pump test important and, in the absence of a cost free PG&E program, are willing to pay at least 70% (or more) of the typical pump test charges. The remaining 69 customers do not consider the information from a pump test as important and hence are not willing pay for it. These responses indicate that there may be a market for a pump test service in which the customers pay for the service.

The DCA indicated that PG&E's AEMS pump test program actually discourages customers from understanding the cost of a pump test. Not one of the 204 'rational' customers behaved as such due to the program. Out of a total of 196 'not rational' customers, 111 were participants. The negative DCA result indicates that 24% of the 111 participants who are not 'rational' would have been willing to pay for a test if the program was not offered. Agricultural customers are so used to getting a pump tested by PG&E without paying anything, that now they are not prepared to pay for it. The confidence interval indicates that a minimum of 1 or a maximum of 3 participants (out of 10) who are currently not 'rational', would have been 'rational' if the program was not in place. Thus, the analysis indicates that the program discouraged customers to pay for the services.

Conclusion

The analysis indicates that the program appears to have played only a small part in creating the motivation to seek information regarding efficient technologies, and in making customers feel interested in knowing the efficiency of their pumps. PG&E via AEMS pump test program has successfully assured some of the customers that the pump test results are believable. But in the present context, when a majority of agricultural customers are motivated, interested and convinced and are going to remain motivated, interested and convinced in the future, PG&E's program has minor role to play. The survey results indicate that the level of awareness, attitude and behavior among agricultural customers is currently, and is perceived to remain, towards efficiency in the future. In order to target a specific group of customers that are not motivated, not interested, and not convinced, PG&E may need to investigate how to best target them.

A competitive market for pump tests is emerging as a result of the motivation and awareness about the importance of knowing efficiency, and performance certainty developed by the program and other factors. However, by providing pump tests at no cost, the program discourages customers from using the pump test services offered by agencies other than PG&E.

Potential Method Improvements

The main disadvantage of the approach in this study is that overall effects can not be studied simultaneously. Instead, the effect of the program is estimated specifically for each market barrier. This is mainly due to two reasons. First, the importance of each market barrier is different at different time points. For example, lack of motivation among customers could have been a major issue for a market in the initial stage of introducing the efficiency concept and now it is no longer as important. Second, the extent of change in one market barrier is not the same as the change in another market barrier. These two are interrelated. In this approach, a program that has remained the same for many years is

not expected to affect each market barrier to the same extent. Though the disadvantage is that an overall market effect is not estimated, the advantage is that it gives specific treatment to each market barrier.

Though the market barriers are inter-related, the current approach assumes them to be independent. An attempt was made to study the interdependency of the market barriers but due to multicollinearity the effect was not successfully separated. Also, the differences in the importance of each market barrier at different times, makes it difficult to study the linkages. For example, customers who are not aware of a pump test may not have an idea about whether they believe in pump test projections or not.

Market factors change over a period of time. Customers can not reliably provide us year-specific opinions about market barriers. In addition, the market factors are inter-related and these relationships change over time. The approach presented in this study cannot estimate year-specific market effect.

This approach uses customers' perceptions and opinions (collected via a telephone survey) in a discrete choice model to associate causality between their perceptions of each market barrier and program participation. This may not be sufficient for compensating PG&E for the market effect attributable to the AEMS pump test program.

The approach can be more useful if in-depth interviews with different market actors can be used along with the telephone survey. With detailed information, it may be possible to understand what influences each market barrier and an attempt can be made to analyze the process better and deal with each market barrier if it causes a problem in transforming the market.

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