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Optimal Institutional Mechanisms for Funding Generic Advertising: An Experimental Analysis

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Abstract

Given the uncertain legal status of generic advertising programs for agricultural commodities, alternative voluntary funding institutions are investigated hat could provide a high level of benefits to producers. This experimental study simulates key economic and psychological factors that affect producer contributions to generic advertising. The results suggests that producer referendum play a critical role in increasing contributions and that producer surplus is maximized by a Provision Point Mechanism instituted by producer referendum with thresholds ranging from 68% to 90%, and expected funding from 47% to 77% of the time, depending on the level of advertising effectiveness.

Key words:

generic commodity advertising, experimental economics, producer referendum, provision point mechanism

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Generic advertising programs have been a popular tool used by many agricultural commodity organizations in the United States to enhance market demand, raise prices, and increase producer net revenue. These programs operate by assessing producers in an industry and using the collected funds for generic (non-branded) advertising and promotion of the commodity. Currently, there are thirteen federal programs and over fifty state programs in existence. The majority of economic studies evaluating generic advertising programs have found large benefits for producers relative to costs.

Funding for some commodity programs originally came from voluntary donations from participants via a voluntary contributions mechanism (VCM). While initial contributions for the advertising programs using a VCM were typically high, free-riding and decreased donations eventually became a significant problem, raising questions of equity and fairness. As a result of these concerns, essentially all VCMs were abandoned and producers held referenda on whether to adopt mandatory assessments to fund the advertising programs. Virtually all programs in operation today are mandatory, as all producers are required to pay assessments based on their marketing volume.

However, some individual producers have recently challenged the constitutionality of mandatory generic advertising programs arguing that being required to contribute money to generic advertising programs is an infringement of their rights to free speech. Currently, there are over 70 First Amendment challenges to generic advertising programs being litigated. To date, there have been decisions delivered by district and circuit courts on both sides of the issue, upholding the constitutionality of some of the programs and ruling others unconstitutional. In their review of these lawsuits, Crespi and Sexton conclude that court actions from parties opposed to mandatory participation threaten to undermine the current system of generic advertising. Because of these challenges, there is a need to assess whether a new institutional arrangement that maintains the voluntary spirit of the court findings will achieve the same goals and benefits of generic advertising.

The U.S. Supreme Court has issued opinions in two cases and will be hearing a third case in 2005. In *Glickman v. Wileman* (1997), the Court ruled that the advertising program for California peaches, plums, and nectarines does not violate the First Amendment. The Court reasoned that generic advertising was part of a broader set of economic regulations (i.e., a marketing order) in which producers were already "constrained by the regulatory scheme," and hence exempt from the First Amendment challenge. However, in 2001, the Court ruled in *U.S. v. United Foods* that the mushroom advertising program was unconstitutional since the only purpose of the program was speech – that is, advertising. The Court cited the fact that, unlike the California peaches, plums, and nectarines program, the mushroom program was a stand-alone program for advertising and not part of a broader set of regulations restricting marketing autonomy. The Court is set to hear arguments on one of the larger programs (beef), with a decision expected in mid-2005.[1] As these court battles continue, producers and commodity programs face the question of what type of funding mechanism should replace the current mandatory ones if (or when) they are ruled unconstitutional.

An alternative funding mechanism that could potentially yield long-term benefits to producers is the provision point mechanism (PPM) for public goods. The PPM, which has never been used to fund generic advertising for agricultural commodities, has two desirable characteristics given the current legal environment: (1) it is voluntary and thus would not likely be vulnerable to legal challenges based on freedom of speech, and (2) it has been shown in both the lab and the field to reduce the incentives for free-riding and to generate greater total contributions than the VCM does (Isaac, Schmidtz, and Walker; Suleiman and Rapoport; Dawes et al.; Marks and Croson 1998, 1999; Rondeau, Poe, Schulze; Rose et al.).

The PPM operates by announcing a threshold (or goal) for the fundraising campaign and soliciting contributions to achieve this threshold. If the threshold is met or exceeded, the contributions collected are used to fund the public good; otherwise all of the contributions are returned and no funding is provided. In contrast, while a VCM also frequently includes the announcement of a goal (such as with fundraising campaigns for the United Way, National Public Radio, or religious organizations), the VCM retains whatever is contributed regardless of whether the goal is achieved, leaving the organization to either adjust to a lower budget level or extend the time frame of the fundraising effort.

With the PPM, the combination of the "money-back guarantee" and the threat of complete funding shut-down if the threshold is not achieved has been shown to increase contributions (Rapoport and Eshed-Levy; Cadsby and Maynes). In situations of complete information, the PPM has desirable theoretical properties with the dominant Nash equilibrium being for each subject to cost-share, where the sum of contributions equals the cost of the threshold (Bagnoli and Lipman). Since mandatory programs are still constitutional for most commodities, the economic experimental laboratory provides an ideal setting in which to explore the benefits and optimal design of a PPM in case an alternative mechanism becomes needed.

Two recent studies (Krishnamurthy; Messer, Kaiser, and Schulze) provide experimental evidence of the attractiveness of the PPM for generic commodity advertising, showing the PPM to reduce free-riding and generate greater total contributions relative to the VCM. Messer, Kaiser, and Schulze further demonstrate that critical psychological and economic conditions created in the laboratory can produce experimental results for contributing to generic advertising that closely parallel historic results observed in the egg industry. However, Messer, Kaiser, and Schulze considered only one PPM threshold (70%). Several key questions related to the institutional design of a PPM need to be explored to find the combination of features and procedures that could lead to maximum producer welfare.

The first question that arises is what impact producer referenda have on contributions to the advertising program and, ultimately, on producer surplus. Producer referenda are part of essentially all generic advertising programs. Referenda are often used when the program is contemplating a change in its operation or funding structure. However, the impacts of referenda on public good giving have not previously been given much attention. A study by Alm, McClelland, and Schulze suggests that voting creates a social norm that can positively affect the level of contributions to public goods. To our knowledge no one has examined the impact of referenda on contributions and threshold achievement in the PPM.

The second question is what the optimal threshold for the PPM is. The third question is what combination of institutional features leads to stability of contributions to the advertising program over time. The fourth question is the impact that effectiveness of the advertising program has on producer contributions. These questions are the subject of the research summarized in this paper.

The remainder of this paper is organized as follows. In the next section, the experimental design is presented. This is followed by a presentation of the results, including the application of a mixed-effects econometric model to identify the important determinants of producer surplus and contributions to advertising over time. Finally, a summary of the main findings and policy implications is presented.

Experimental Design

Each experimental session involved three separate parts. The first two parts were designed to familiarize subjects with the experimental platform and to demonstrate to subjects the benefits of the advertising program. Part A of the experiment had no advertising program, Part B had an advertising program whose funding was mandatory, and Part C had an advertising program whose funding was provided through a PPM with a varying threshold. The order of these three parts mimics the possible succession of generic advertising policies over time should mandatory programs be ruled unconstitutional. In each experimental session, twenty subjects assumed the role of producer.

Subjects were unaware in advance of the number of parts of the experiment. At the beginning of each part, subjects read the instructions and then the administrator orally described the experiment and answered all subjects' questions. The first part of the experiment consisted of five rounds and did not include the advertising program. Subjects were randomly assigned to a computer that had a spreadsheet informing them of their costs for producing up to three units of a fictitious commodity. In each round, subjects submitted their offers to sell each of their three units. These offers were sent directly to an Access database using Visual Basic for Applications. The quantity demanded was determined after all the offers were submitted. Subsequently, the administrator calculated the market price based on the offers and quantity demanded. When notified by the administrator, the subjects retrieved the market price and learned whether they had sold some or all of their units. The subjects' spreadsheets calculated their profit in each round.

In the experiment, demand was assumed to be perfectly price inelastic and the administrator assumed the role of buyer in the market. For each round, stochastic demand was determined by a subject randomly drawing a ball, with replacement, from a bag containing labeled bingo balls numbered from forty to forty-six. The number on the drawn ball represented the number of units demanded. A triangle distribution, which approximates a normal distribution, was used, thereby creating price fluctuations that mimicked the price changes observed for many agricultural commodities.[2]

Since the objective of this research was to answer the four questions related to producer contributions in response to varying mechanism designs, the simplifying assumption of a perfectly inelastic demand was made to ensure that the stochastic demand was transparent to subjects. Furthermore, this assumption helped to ensure control over the rate of return on advertising. This assumption is plausible, as previous estimated demand elasticities for some agricultural commodities have been quite inelastic (e.g., fluid milk, -0.04 (Schmit and Kaiser, 2004); eggs, -0.02 to -0.17 (Brown and Schroeder); walnuts, -0.08 (Kaiser, 2002), almonds, -0.20 (Crespi and Chacon-Cascante); and pork, -0.20 (Reed, Levedahl, and Clark)).

Each subject could produce up to three units; therefore, in each round there were a total of sixty units available. Each subjects' costs were constant throughout the experiment. Subjects paid the cost of producing the units only if the units were successfully sold, a simplification that ensured that the experiment had control over the rate of return on advertising. The subjects' first two units cost the same, $1.00, therefore all subjects had a strong incentive to have an increase in price. The subjects' third unit cost more, distributed from $1.10 to $5.06, and established the supply elasticity of 0.25. The own price elasticity of supply of 0.25 is also in the range of estimates of the supply elasticities for agricultural commodities (e.g., milk, 0.30 (Chavas and Klemme),[4] eggs, 0.20 (Schmit and Kaiser, 2003), and beef, short-run 0.05 to long-run 0.45 (Buhr and Kim)).

For each round, the market price was determined using a uniform price auction, which sets the price for all units sold at the *first rejected offer*. The uniform price auction, also referred to as a Vickrey or N^{th}-price auction, is common in experimental settings because of its transparency, ease of administration, and incentive-compatible characteristics, especially when the quantity demand has a stochastic component (Davis and Holt, Shogren et al.). Once all of the sellers submitted their offers, the administrator sorted all of the offers from lowest to highest. A ball would then be drawn to determine the quantity of demand and the administrator would purchase all of the units needed. The lowest offer *not purchased* (the first rejected offer) would determine the price for all of the units purchased. For example, if demand was determined to be 43 then the producers of the 43 units with the lowest offers would sell their units and receive a price equivalent to the 44th lowest offer. In the written and verbal instructions, subjects were informed that the market was competitive and therefore, submitting offers equal to their costs was in their best interest, because they might otherwise forgo profitable trades.

Part A (no advertising) consisted of five rounds, followed by five rounds in Part B (mandatory advertising). In Part B, all sellers were required to pay an assessment for each unit sold and these assessments provided the funds for the advertising program that increased demand in the subsequent round, thereby creating a one-round lag between the cost of the advertising program and its benefits. The increase in demand was determined by the equation

(1) $$D_{Increase} = \delta \sum_{i=1}^{n} A_i$$

where A_i is the amount of assessments collected for each subject, $i = 1,\ldots,20$ and $\delta \in \{4/9, 6/9, 8/9\}$ determines the benefit-cost ratio for the advertising campaign (2:1, 4:1, and 6:1, respectively). The benefit-cost ratio was constant throughout an experimental session. In a step that parallels the publicity provided by commodity programs about the benefits of marketing efforts, subjects were informed prior to implementation that the advertising program not only increased demand, but that the higher demand would also result in higher prices and higher profits for sellers.

In reality, not all producers are notified of the true increase in demand due to advertising. However, since independent economic evaluations are required of all federal generic advertising programs, many farmers do read or hear about the estimated impacts of generic advertising on demand, prices, and profits. For example, the generic dairy advertising programs have an annual, independent economic evaluation, and the results are widely disseminated to dairy farmers by the government, dairy checkoff program, and popular trade magazines.

The assessment rate was set at $0.25 per unit sold, so that when combined with the increase in demand, the uniform price auction, and the cost structure described above, the rate of return to advertising could be controlled ranging from 2:1 to 6:1. These rates of return are similar to the rates of return commonly observed with generic commodities (table 1).[5] Control of the rate of return was the most critical economic element to simulate in the experiment, since the rate of return has been shown to have a direct effect on subject behavior in the PPM (see for example Rondeau, Poe, and Schulze). In the instructions, subjects were provided with estimates of the expected price that would result from different amounts of assessment collected given the experiment's uniform price market, stochastic demand, and cost structure. For each round, in addition to the market price, the administrator announced the total assessments collected and the corresponding increase in demand.

Simulating the potential change that could result if mandatory programs are ruled unconstitutional, Part C of the experiment replaced the mandatory program with a voluntary PPM. It involved fifteen rounds, where subjects experienced five consecutive rounds for each of three different PPM thresholds.[6] This part also mimicked a funding feature common to many generic advertising programs funded via a VCM: refund-by-request. In such programs, assessments for the advertising campaign were collected at the point of sale and producers had to make a written request to get their assessment refunded. As shown in Messer, Kaiser, and Schulze, this refund-by-request feature leads to increased levels of voluntary contributions in both the VCM and PPM. Thus, in our experiments, subjects could request a refund of part or all of their assessment by submitting a confidential one-sentence request using instant messaging to the administrator (sample message: "Subject #2 requests a refund of $0.75 for Round 8, Sincerely, John Doe."). If a subject did not want to request a refund, no message was required. All refund requests were granted and refunds were added to the subject's profits.[7]

To test the influence of producer referenda on contribution behavior, in one-half of the experimental sessions, subjects were asked to submit confidential votes on whether they would prefer the PPM with a certain threshold level or whether they would prefer no advertising program. Referenda were held prior to the start of a series of rounds for each PPM threshold. In the other half of the experimental sessions, subjects were not given a choice and were simply informed that for the next series of rounds the advertising program would be funded by the PPM with a certain threshold level.

To simulate the democratic decision-making process among producers that occurs with generic advertising programs, subjects in the referendum sessions were given five minutes to discuss the referendum on the PPM and strategies for making contributions to the advertising program. For the non-referendum sessions, subjects were only permitted to discuss strategies for making contributions to the advertising program. Such conversations are commonly referred to as "cheap talk," since no binding deals are allowed and the actual decisions are confidential. Note that discussion of pricing strategies was not allowed in any of the cheap talk conversations.

Unlike in Part B, where the advertising program was always implemented, in Part C the advertising program was implemented only if the PPM threshold was met or exceeded.[8] The subject participation thresholds used in the experiment were 50%, 70%, and 90%. Subjects participated in five consecutive rounds for each of the three thresholds. The order of the thresholds was varied for each experimental session to mitigate potential order effects. To understand how the PPM operated, consider the case where the threshold was 90%. In this case, the advertising campaign would be implemented only if at least 90% of the subjects *did not request* refunds.[9] If three or more of the twenty subjects in the experiment requested refunds, the advertising program was not implemented and all twenty subjects received a refund of their assessments, whether they initially requested a refund or not. In the case of a group refund, the round operated identically to Part A, where there was no advertising program. In the subsequent round, subjects were given the opportunity to reach the threshold again. If the threshold was achieved, the advertising program was implemented and the assessments collected determined the increase in demand for the subsequent round. After each round, the administrator announced the total assessments possible, the total assessments collected, the number of subjects not requesting a refund, whether the threshold was achieved, and the corresponding increase in demand, if any.

Results

All experiments were conducted at the Laboratory for XXXX at XXXX University and the subjects were recruited from undergraduate economics courses. In total there were twelve experimental sessions, each involving twenty subjects (n=240). This section first provides aggregate descriptive statistics of the initial eight experiments where the benefit-cost ratio of generic advertising was calibrated at 4:1, indicating the importance of the referendum on contributions and key trends observed with regard to the referenda and PPM thresholds. Then, econometric models are developed to identify the combination of institutional mechanisms that are both stable and maximize individual producer surplus and contributions to the advertising program. Sensitivity analysis is subsequently conducted with the additional experimental data to determine the impact of alternative levels of advertising effectiveness on optimal PPM thresholds and subject contributions.

As noted earlier, Part A of the experiment did not include the advertising program and was designed so that subjects could become familiar with the experimental platform and the uniform price auction. Over these five rounds, the average per round producer surplus was at its lowest level of the experiment, \$31.17 (table 2). In contrast, in Part B, where the advertising program is funded by mandatory assessments, the average producer surplus over the five rounds increased to \$95.17, the highest of the experiment.[10]

In Part C, subjects were faced with the decision of how much to contribute voluntarily to the advertising program, with funding governed by three different PPM thresholds (50%, 70%, and 90%). Under all three PPM thresholds, producer surplus was significantly higher (\$68.21, \$88.96, and \$75.06, respectively) than in Part A, where there was no advertising, but lower than in Part B, where there was an advertising program with mandatory funding (table 2).[11]

Table 2 also illustrates that referenda do matter with respect to producer surplus and contributions to the advertising program. Producer surplus is significantly higher in sessions with a referendum than in those without one.[12] Recall that all sessions included cheap-talk about contribution strategies. Cheap-talk discussions (like public discussions among producers) tend to elicit the opinions of those individuals who are more extroverted and more open to expressing their opinions in a public setting. In contrast, a referendum gives every individual an opportunity to express their opinion as the results of the referendum are announced to the group. This difference in producer surplus suggests that confidential referenda provide critical feedback to subjects about the sentiments of other members of their group toward the PPM threshold and their likely behavior should the PPM be approved by vote. Since the votes were overwhelmingly in favor of the PPM thresholds (at or above 95% for each threshold), the referenda appear to have signaled a greater sense of producer support than was permitted in the cheap-talk discussion alone. Since generic advertising programs generally enjoy broad support from producers, this finding is particularly relevant to the institutional design of potential voluntary generic advertising programs.

The higher producer surplus in the referendum sessions can be attributed to higher voluntary contributions to the advertising program from subjects. A striking result, displayed in figure 1, is that subjects offered higher average contributions (not accounting for whether the threshold was achieved) in the referendum sessions than in the non-referendum sessions. Using the test of proportions, these contributions were significantly higher ($\alpha < 0.05$) for all PPM thresholds. Even though the percentage of contributions was less then the percentage voting in favor of the PPM threshold, it appears that including referenda in the program design does significantly increase contributions, and thereby, increases producer surplus.

Figure 1 shows the strong positive relationship between group contributions and PPM thresholds. That is, a higher PPM threshold leads to higher contributions from producers. However, as in other experiments involving repeated PPM rounds (e.g., Isaac, Schmitdz, and Walker; Marks and Croson, 1998, 1999), producers did not always reach the threshold. In fact, the frequency with which the group achieved the threshold declined as the threshold rose (figure 2). For the referendum sessions, as the threshold increased from 50% to 70% to 90%, the frequency with which the threshold was achieved decreased from 95% to 90% to just 65%, respectively. Likewise, for the non-referendum sessions, the frequency with which the threshold was achieved went from 70% to 65% to just 40%, respectively, as the PPM increased over these three thresholds. These latter results further illustrate the importance of producer referenda in the advertising program design.

In the field, this lack of certainty regarding the achievement of the threshold could cause logistical concerns for the advertising agency in charge of the campaign since the stream of revenue for advertising could abruptly be turned on and off. Therefore, a practical trade-off exists between high levels of producer contributions and actually achieving the PPM threshold necessary to implement the program (and retain these contributions). We evaluate this tradeoff more formally in the next section, by estimating PPM thresholds for which producer surplus and expected advertising contribution probabilities are maximized when threshold levels are treated as a continuous variable.

Econometric Model

Econometric models were developed to determine the relationships between producer surplus and advertising contributions on PPM threshold level, accounting for market demand, group referendum type, and treatment round. The models were specified to account for the three-level hierarchical nature of the experimental data, where subject-level information is nested within experimental groups (or blocks) and observed over rounds (i.e., repeated measures). Given the differentiation between group and subject effects (fixed or random), we used a General Linear Mixed Model (GLMM) format to define the data generating processes; i.e.,

(2) $\mathbf{Y} = \mathbf{X}\boldsymbol{\beta} + \mathbf{Z}\mathbf{u} + \mathbf{e}$,

where $\mathbf{Y}$ is a $gsT \times 1$ vector for the particular dependent variable ($i = 1,\ldots,g$ groups, $j = 1,\ldots,s$ subjects, and $k = 1,\ldots,T$ time periods), $\boldsymbol{\beta}$ is an unknown $b \times 1$ vector of fixed-effect parameters with known $gsT \times b$ design matrix $\mathbf{X}$, $\mathbf{u}$ is an unknown $c \times 1$ vector of random-effect parameters with known $gsT \times c$ block design matrix $\mathbf{Z}$, and $\mathbf{e}$ is an unknown $gsT \times 1$ random vector of experimental errors that accounts for both the subject covariance within groups and autocorrelation of subject errors observed across rounds. Note that fixed-effects defined in $\mathbf{X}$ and random-effects defined in $\mathbf{Z}$ may contain either subject-level factors, group-level factors, or both. Further assume that $\mathbf{u}$ and $\mathbf{e}$ are normally distributed random variables with

(3) $\mathrm{E}\begin{bmatrix}\mathbf{u}\\ \mathbf{e}\end{bmatrix} = \begin{bmatrix}\mathbf{0}\\ \mathbf{0}\end{bmatrix}$ and $\mathrm{Var}\begin{bmatrix}\mathbf{u}\\ \mathbf{e}\end{bmatrix} = \begin{bmatrix}\mathbf{G} & \mathbf{0}\\ \mathbf{0} & \mathbf{R}\end{bmatrix}$.

The variance of $\mathbf{Y}$ is therefore

(4) $\mathbf{V} = \mathbf{V}(\mathbf{Y}) = \mathbf{Z}\mathbf{G}\mathbf{Z}' + \mathbf{R}$.

The variance $\mathbf{Y}$ is modeled by specifying the forms of $\mathbf{Z}$, $\mathbf{G}$, and $\mathbf{R}$. The model matrix $\mathbf{Z}$ is set up in the same fashion as matrix $\mathbf{X}$, where a parametric structure is selected for the covariance matrices $\mathbf{G}$ and $\mathbf{R}$.

Group effects are represented by random block effects (via **Z** and **u**), since the groups represent an expected small subset of a larger set of groups over which inference about treatment means is to be made. Assuming block effects are distributed normally and independently with mean 0 and variance σ_B^2, **G** is a g x g diagonal matrix with σ_B^2 on the diagonal, and **Z** a gsT x g matrix of ones and zeros reflecting the random block effects.

To account for autocorrelation in subject errors across rounds, we assume a compound symmetric, within-subject covariance structure, such that for each subject's T x T matrix $\mathbf{R_{ij}}$ we have[13]

$$(5) \quad \mathbf{R_{ij}} = \begin{bmatrix} \sigma_R^2 + \sigma_S^2 & \sigma_R^2 & \cdots & \sigma_R^2 \\ \sigma_R^2 & \sigma_R^2 + \sigma_S^2 & & \vdots \\ \vdots & & \ddots & \sigma_R^2 \\ \sigma_R^2 & \cdots & \sigma_R^2 & \sigma_R^2 + \sigma_S^2 \end{bmatrix} \forall\ i = 1,\ldots,g;\ j = 1,\ldots,s,$$

where σ_R^2 is the autocorrelation compound symmetric variance component between any two observations on the same subject and σ_S^2 is the residual within group subject variance. The complete gsT x gsT **R** matrix is block diagonal, with each T x T block corresponding to a single subject, nested within groups.

When considering alternative PPM thresholds from a marketing/program logistics standpoint, being able to sustain the advertising program throughout variations in the funding stream is important. Therefore, we conduct additional modeling to determine the effect of PPM thresholds on the proportion of assessments contributed to the advertising program. Since most contributions are either all (entire assessment) or nothing (full refund requested), we model the probability of subject advertising contributions using a binomial probit function.[14]

Specifically, assume now that $\mathbf{X\beta} + \mathbf{Zu}$ is a generalized linear mixed model of the underlying process. Then the probability of a subject contribution to the advertising program is Prob(contribute) = $\Phi(\mathbf{X\beta} + \mathbf{Zu})$. The probit model can be expressed as

$$(6) \quad z^*_{ijk} = \mathbf{X}_{ijk}\boldsymbol{\beta} + Z_i u_i + e_{ijk} \quad \text{where} \quad z_{ijk} = \begin{cases} 1 \; if \;\; z^*_{ijk} > 0 \\ 0 \; otherwise \end{cases},$$

where z^*_{ijk} is the unobserved (latent) variable for group *i*, subject *j*, round *k*, corresponding to the observed dependent binary response variable z_{ijk}, and the hierarchical error structure is defined as above with the exception of the probit link error function.

Empirical Results

As discussed above, since the primary goals of generic advertising programs are to expand demand and increase producer returns, we first examine econometrically the impact of PPM thresholds on producer surplus to determine the optimal threshold. Following the mixed model structure, we hypothesize the empirical model as

$$\begin{aligned}(7) \quad GPSRPLS_{ijk} &= \beta_0 + \beta_1 ADVCONT_{ijk-1} + \beta_2 DEMAND_{ik} + \beta_3 PPM_{ik} + \beta_4 PPM^2_{ik} \\ &+ \beta_5 ROUND_{ik} + \beta_6 PPM_{ik} GRPREF_i + \beta_7 PPM_{ik} ROUND_{ik} + \beta_8 ROUND_{ik} GRPREF_i \\ &+ Z_i u_i + e_{ijk},\end{aligned}$$

where $GPSRPLS_{ijk}$ is gross producer surplus for group *i*, subject *j*, round *k*,[15] ADV_CONT_{ijk-1} is the final advertising contribution (assessment less refunds received) for group *i*, subject *j*, round *k-1*,[16] $DEMAND_{ik}$ is market demand for group *i*, round *k*, PPM_{ik} is the provision point threshold for group *i*, round *k*, $ROUND_{ik}$ is the round number for group *i* to account for additional round fixed-effects (e.g., behavior change over time) not accounted for by the random error assumptions, $GRPREF_i$ is a dummy variable reflecting whether group i is a referendum session ($GRPREF$=1) or non-referendum session ($GRPREF$=0), and $Z_i u_i$ and e_{ijk} reflect the error components as described above.

PPM interaction variables reflect the *a priori* hypothesis that threshold effects will vary across voting group types and over program duration. In addition, given that in the referendum sessions subjects voted on implementing the PPM program before the first round for each threshold, it is expected that round effects will vary across voting group types. PPM thresholds are included in (7) in quadratic form to transform the threshold class levels to a continuous basis and thereby allow computation of the threshold where producer surplus is maximized.

Subsequently, the advertising contribution probability model was specified as

$$(8)\quad CONT_{ijk} = \beta_0 + \beta_1 COST_{ij} + \beta_2 PPM_{ik} + \beta_3 PPM_{ik}^2 + \beta_4 ROUND_{ik} + \beta_5 PPM_{ik} GRPREF_i + PPM_{ik} ROUND_{ik} + Z_i u_i + e_{ijk},$$

where $CONT_{ijk}$ is equal to one if the group i, subject j, round k final advertising contribution is greater than zero, and equal to zero if the final contribution is zero, and $COST_{ij}$ is the third unit cost for group i, subject j (costs do not change over time). Recall that the final contributions can be equal to zero either by a subject refund request or by a group refund, if the threshold was not achieved; so both individual and group effects are inherent in the variable modeled. Since the contributions were not dependent upon the previous round, all five rounds for each PPM threshold were used in the analysis.

Producer Surplus Model Estimates

Regression estimates for both models and utilizing the experimental data calibrated on a benefit-cost ratio of 4:1 are included in table 3. All estimated parameters were statistically significant for the producer surplus model at the 0.05 significance level or less.[17] The statistical significance of the covariance parameter estimates lends support to the hypothesized three-level hierarchical error structure. As expected, both demand and final advertising contribution levels were significantly high given the price impacts from changes in demand (as described previously).

PPM thresholds significantly affected producer profits, as did their effects across referendum groups and program duration (round). Simulation of the econometric model indicates that with the exception of the lowest threshold levels, predicted gross producer surplus in the referendum program were dramatically higher than those in the non-referendum program**.** For the referendum program, these relationships are illustrated in figures 3, which computes predicted gross producer surplus across thresholds and rounds.

Also apparent from the simulation is the answer to the third question regarding the stability of producer surplus across rounds. While the sign on *ROUND* is negative suggesting deterioration in return levels over time, when interacted with the other variables included in the model, the net effect is one of improved stabilization for the referendum program, particularly near the optimal PPM threshold level of 82% (figure 3). In fact, model simulations show that the round-by-round changes in gross producer surplus were over six times larger in the non-referendum programs than in the referendum programs. Certainly, the higher and more stable gross producer surplus levels validate the inclusion of voting in PPM-funded programs. That producers can maximize higher profit levels at relatively higher PPM thresholds also means that additional funding goes to the generic promotion program, resulting in larger demand-enhancing impacts.

Subject Advertising Contribution Probability Estimates

As was described above, average intended contributions to the advertising program rose with increases in threshold levels; however, at the same time, the frequency of threshold achievement fell. While the prospect of a bigger advertising budget under a higher PPM threshold is appealing, higher thresholds may be more difficult to achieve, and the increased likelihood of non-funded years would make the development of a marketing program that much more difficult. A low threshold may be more feasible to achieve, making funding for advertising more consistent, but a low threshold also enables more producers to "free-ride," and total contributions are consequently lower.

We conduct additional analysis to examine the subject-level probability of positive final advertising contributions across PPM thresholds to evaluate expected threshold achievement. By using final advertising contributions, we account for both individual refund requests and refunds received as part of a group refund, whether the individual subject requested a refund or not. Furthermore, we examine whether optimal PPM thresholds for maximizing gross producer surplus levels are consistent with the PPM threshold that maximizes the producer's probability of contributing.

As did the econometric results for producer surplus levels, final contribution probabilities demonstrated a statistically significant positive relationship to the PPM threshold (table 3).[18] The quadratic PPM term was also significant and negative. The interaction effect of the referendum with PPM threshold was a significant determinant of contribution probabilities. Relative to the referendum program, the non-referendum programs demonstrated a greater decrease in contribution probabilities as PPM thresholds increased. On a subject-level basis, producers with higher third unit costs were less likely to contribute to the advertising program. Program duration (round) had a significant effect on contribution probabilities, and, over time, contribution probabilities gradually improved at thresholds at or above 62% as the potential to free-ride diminished.

The relationship of the final contribution probability across PPM thresholds and rounds (at mean cost level) is illustrated in figure 4 for the referendum program. Simulations of the econometric results suggest that threshold and round effects are similar for both the referendum and non-referendum programs. However, the predicted probabilities are scaled down considerably for the non-referendum program. At lower PPM thresholds, contribution probabilities are lower due to the increased ability to free-ride, while at higher PPM thresholds contribution probabilities are lower due to the increased frequency of not achieving the threshold level.

Overall, the behavior exhibited appears to be approaching the Nash equilibrium of cost-sharing, though this study used percent participation, rather than percent contribution, as determining whether the threshold was achieved. Evaluated at the final round, the maximum contribution probability for the referendum program was 77.5%, achieved at a PPM threshold of 76%. Put differently, for an assumed rate of return to advertising of 4:1, this implies that a 76% threshold would be met or exceeded 77.5% of the time. For the non-referendum program, the maximum contribution probability was 53.6%, achieved at a PPM threshold of 71%. Furthermore, evaluating the contribution probabilities based on the PPM threshold that maximized producer surplus (i.e., 82% for the referendum program and 74% for the non-referendum program) indicated only slightly smaller contribution probabilities of 76.2% and 53.2%, respectively.

Sensitivity Analysis on Advertising Effectiveness

As mentioned above, control of the rate of return was the most critical economic element to simulate the experiments. Also, given that a wide array of rates of return to generic promotion programs exist in the literature, it is useful to examine how changes in this return translate into changes in subject behavior and, ultimately, on optimal threshold levels. We conducted additional experiments calibrated at return levels both above (6:1) and below (2:1) the initial experimental settings. While these additional experiments do not capture the entire range or reported payoff ratios, we felt that they provide additional insight into the role of program efficacy on contributions in a PPM setting.

As expected, as benefits from advertising increased, so did subject contributions. Specifically, the average percentage of contributions increased from 59% in the case of a 2:1 BCR, to 63% for the 4:1 BCR, and to 68% for the 6:1 BCR across all threshold levels. The improved demand enhancing impacts as advertising's rate of return increased were also reflected in the average producer surplus levels across BCRs (table 4).

Supplemental regressions of similar form and specification to the 4:1 BCR data were conducted on the additional sets of advertising payoff experiments.[19] Given the changes in contribution behavior, it is not surprising that as advertising effectiveness decreases, so does the PPM threshold level that maximizes gross producer surplus. The optimal PPM threshold dropped from 82% to 68% as the BCR decreased from 4:1 to 2:1 (table 4). Likewise, as effectiveness improved, the optimal threshold level reached the maximum threshold level evaluated within the experimental data; i.e., 90%. Expected threshold achievement at the 6:1 advertising effectiveness level was similar to that observed in the 4:1 case (77% and 76%, respectively). However, as effectiveness dropped to 2:1, expected threshold achievement dropped sharply to less than 50% of the time (table 4).

The range in optimal thresholds and expected threshold achievement highlights the crucial nature of the underlying advertising performance measure in the experimental set up. An additional realization is that if commodity programs go to a voluntary PPM type of program, knowledge on the relative performance of their promotions programs will be crucial to setting PPM operational parameters in order to maximize the benefits to the producers funding the program through their checkoff assessments.

Conclusions

In light of uncertainties about the constitutionality of mandatory generic advertising programs for agricultural commodities, it is useful to investigate alternative voluntary funding mechanisms in case they become needed. The economics laboratory is an ideal environment in which to conduct this investigation, as key economic and psychological factors can be simulated, enabling a careful analysis of the impact of various features of a funding mechanism on producer contributions to generic advertising programs. The focus of this analysis was on finding the combination of features and procedures for the Provision Point Mechanism (PPM) that maximizes producer welfare and advertising contributions given the varying effectiveness of the advertising program. In addition to having a PPM with the "refund-by-request" feature as advocated by Messer, Kaiser, Schulze, separate program mechanisms were instituted to investigate the impact of producer referenda on contribution levels over a variety of PPM thresholds. The four issues examined were: (*i*) whether a producer referendum on institutional funding mechanisms had an impact on producer surplus and contributions to the advertising program, (*ii*) what the optimal threshold was for the PPM, (*iii*) how institutional features impacted the stability of contributions to the advertising program over time, and *(iv)* how does the effectiveness of the advertising program affect producer contributions?

The empirical results indicate that including producer referenda as part of the program design positively affects both producer profits and contribution probabilities. Given how participation in these referenda strongly affected subjects' contribution behavior, advertising programs should encourage these types of institutions that help secure higher funding levels. In addition, a substantially higher degree of program stability over time was evident when the program included the referendum and the threshold was set at or near the level where producer profits are maximized.

In programs that included the referendum, producer welfare was maximized at a PPM threshold of 82%, assuming a benefit-cost ratio of advertising at 4:1. At this threshold, program developers should expect that the threshold will be met or exceeded 76% of the time. Sensitivity analysis also showed direct relationships between the effectiveness of the advertising program and both the optimal threshold level and expected threshold achievement. For programs with lower returns (2:1), producer welfare was maximized at a PPM threshold of 68%, which would be expected to be achieved 47% of the time, while for programs with higher returns (6:1), producer welfare was maximized at a PPM threshold of 90%, which would be expected to be achieved 77% of the time.

These results provide valuable information to commodity organizations that wish to design promotion programs that may pass constitutional muster and achieve the largest benefits possible to the producers who fund them. Understanding that estimated producer returns to generic advertising vary over both commodity and time provides direction to future research on the evaluation of contribution behavioral changes and how commodity organizations should best programmatically respond to these changes. Furthermore, extending this type of experimental application to producer groups and commodity organizations is a next logical step in making these types of institutional designs practical in a real-world setting.

Footnotes

[1] The largest generic advertising program, the dairy farmer program, was ruled unconstitutional by the Third Circuit Court in 2004, and may be appealed to the U.S. Supreme Court depending upon its decision in the beef case.

[2] The triangle distribution was also used for its transparency to subjects. Alternative distributions could be assumed and we leave for future research the implications of these distributional assumptions.

[4] Chavas and Klemme's estimated supply elasticity is for a three-year length of run.

[5] While the majority of empirical studies have estimated benefit-cost ratios above 1.0, there are also some studies (particularly in the meat sector, where there is a lot of cross-advertising among commodities) that have indicated little or no impact of generic advertising on demand. Examples of empirical studies that have found little or no impact of generic advertising on demand include Coulibaly and Brorsen, Brester and Schroeder, Kinnucan et al.

[6] Subjects were unaware of the number of rounds for each PPM threshold.

[7] This experiment did not capture the potential affects that the opportunity cost of a contribution to the adverting program that is ultimately returned may have subject behavior. Earnings treated profits from all the parts of a round equally.

[8] In theory, extending the benefits beyond the threshold in this way does not modify the individual incentives (Marks and Croson, 1998).

[9] To increase transparency, the provision point was the "percentage of subjects not requesting refunds," since the number of subjects was always twenty. Alternatively, the provision point could have been the "percentage of assessments collected out of the total possible assessments." However, the total possible assessments varied in each round due

to the stochastic demand. Additionally, a PPM based on the percentage of producer participation is likely to be preferred because of its being perceived as more democratic.

[10] The producer surplus measures are designed to help determine the optimal institutional features, and should not be interpreted as predictions on the magnitude of producer surplus that can be anticipated given these institutional features.

[11] Statistical differences in average group producer surplus measures were computed using a means difference test, distributed *t*.

[12] Producer surplus in the non-referendum sessions was higher than in the referendum sessions of Parts A and B, because of higher average realized demand (stochastic).

[13] Alternative autocorrelation structures were investigated for the repeated-subject measures, including no correlation and autoregressive order-1 processes. The compound symmetric covariance structure better satisfied the Akaike Information Criterion (AIC), and thus, was preferred. Test statistics and alternative empirical results are available upon request.

[14] We also modeled the ratio of net advertising contributions to assessment with logistical transformations of the dependent variable. However, since most observations were either zero or one (i.e., only 6 percent of observations had partial contributions), the empirical results and conclusions were nearly identical to those reported for the probit model. The additional modeling results are available upon request.

[15] Gross producer surplus is defined as subject product sales (market price multiplied by units sold) less costs of production, excluding assessments collected or refunds received. Net program contributions are accounted for on the right hand side of the equation.

[16] Advertising contributions are based on time period *k-1*, since total advertising contributions in time period *k-1* impact demand in time period *k*. Accordingly, the first round of each PPM threshold is dropped from the estimation, since the market demand in the first round of each threshold is based on contributions from the prior round, where the funding was either a mandatory program or provided via another PPM threshold.

[17] Econometric models were estimated using the PROC MIXED procedure in SAS v.8.2.

[18] Note that DEMAND is not included as an explanatory variable in the Probit model. Not only did the inclusion of this variable result in much poorer model performance (AIC=8330.5), but most importantly since subject advertising contributions are based on the assessment collected this indicates directly the quantity of units sold. As such DEMAND is given and need not be included.

[19] For brevity, the supplemental regression estimates are not included, but are available upon request. Optimal PPM thresholds and expected threshold achievement are computed analogously to the 4:1 benefit-cost ratio case.

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Table 1. Estimated average benefit-cost ratios for generic advertising and promotion programs for various commodities.

Commodity	Study	Benefit-Cost Ratio
U.S. dairy advertising	Kaiser (1997)	3.4
U.S. beef advertising	Ward (1998)	4.9 to 6.7
U.S. cotton promotion	Nichols et al. (1997)	3.2 to 3.5
U.S. soybean export promotion & production research	Williams et al. (1998)	8.3
Canadian butter advertising	Goddard and Amuah (1989)	1.0
Florida orange juice advertising	Capps et al. (2003)	2.9 to 6.1
Washington apple advertising	Ward and Forker (1991)	7.0
Walnut domestic promotion	Kaiser (2002)	1.65 to 9.72

Table 2. Average Group Producer Surplus and Expected Contributions (Benefit-Cost Ratio 4:1).

Producer Surplus	Part A (No Program)	Part B (Mandatory)	Part C – Threshold 50%	70%	90%
Part Comparison					
All Sessions (All Groups)	$ 31.17	$ 95.17	$ 68.21	$ 88.96	$ 75.06
Difference from Part A		$ 64.00 **	$ 37.04 **	$ 57.79 **	$ 43.89 **
Difference from Part B			$-26.96 **	$ -6.21 **	$-20.11 **
Difference from Part C (50%)				$ 20.75 **	$ 6.85 **
Difference from Part C (70%)					$-13.90 **
Group Comparison					
Referendum Group	$ 29.98	$ 91.93	$ 77.96	$ 92.60	$ 92.31
Non-Referendum Group	$ 32.35	$ 98.41	$ 58.46	$ 85.33	$ 57.82
Difference	$- 2.37 **	$- 6.48 **	$ 19.50 **	$ 7.27 **	$34.49 **
Group Comparison, Expected Contribution					
Referendum Group			62.9%	70.6%	58.3%
Non-Referendum Group			35.5%	48.4%	33.2%
Difference			27.4% **	22.2% **	25.1% **

n=160

* statistically significant at the 0.05 level, ** statistically significant at the 0.01 level or less

Table 3. Regression Results for Subject Producer Surplus and Probability of Advertising Contribution (Benefit-Cost Ratio 4:1).

	Dependent Variable	
Variable	**Producer Surplus Per Round ($)[a]**	**1/0 Final Advertising Contribution[b]**
INTERCEPT	-10.8288** (0.7073)	-3.5283** (0.7751)
COST		-0.0621* (0.0338)
ADV_CONT_{-1}	0.6167** (0.0894)	
DEMAND	0.2789** (0.0072)	
PPM	0.0510** (0.0160)	0.1217** (0.0212)
PPM*PPM	-0.0004** (0.0001)	-0.0010** (0.0001)
PPM*GRPREF	0.0078** (0.0024)	0.0091** (0.0030)
ROUND	-0.1292** (0.0800)	-0.2535** (0.0866)
ROUND*PPM	0.0039** (0.0011)	0.0041** (0.0012)
ROUND*GRPREF	-0.2215** (0.0353)	
Covariance Parameter Estimates:		
σ_B^2 (Group)	1.1822* (0.6566)	0.2953* (0.1664)
σ_S^2 (Subject)	0.7141** (0.0248)	0.8921** (0.0283)
σ_R^2 (Round)	0.5081** (0.0669)	0.0786** (0.0169)
Fit Statistics:		
-2 Res Log Likelihood	5047.2	7339.6
AIC	5053.2	7345.6
PPM Level where Dependent Variable Maximize (mean ROUND)		
GRPREF = 1 (Yes)	82	73
GRPREF= 0 (No)	74	68

(standard errors in parentheses)
*Significant at the 10% level **Significant at the 5% level or less
[a] Producer Surplus is equal to subject gross profit, excluding advertising contributions.
[b] Binomial error distribution with probit link function

Table 4. Subject Contributions and Optimal PPM Threshold, by Advertising Return Level.

	Benefit-Cost Ratio		
Descriptor	**2:1**	**4:1**	**6:1**
Average Percentage of Contributions	59%	63%	68%
Average Subject Producer Surplus	3.29	4.54	6.29
Optimal PPM Threshold	68%	82%	90%
Expected Threshold Achievement	47%	76%	77%

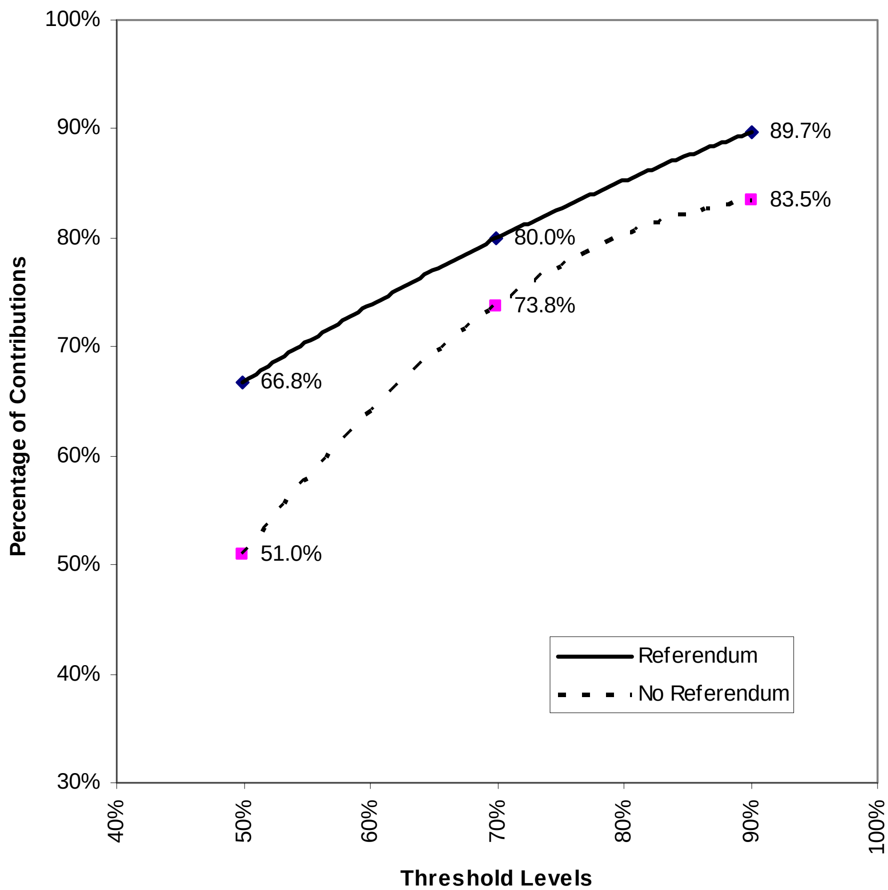

Figure 1. Average Contributions to the Advertising Program (Benefit-Cost Ratio 4:1).

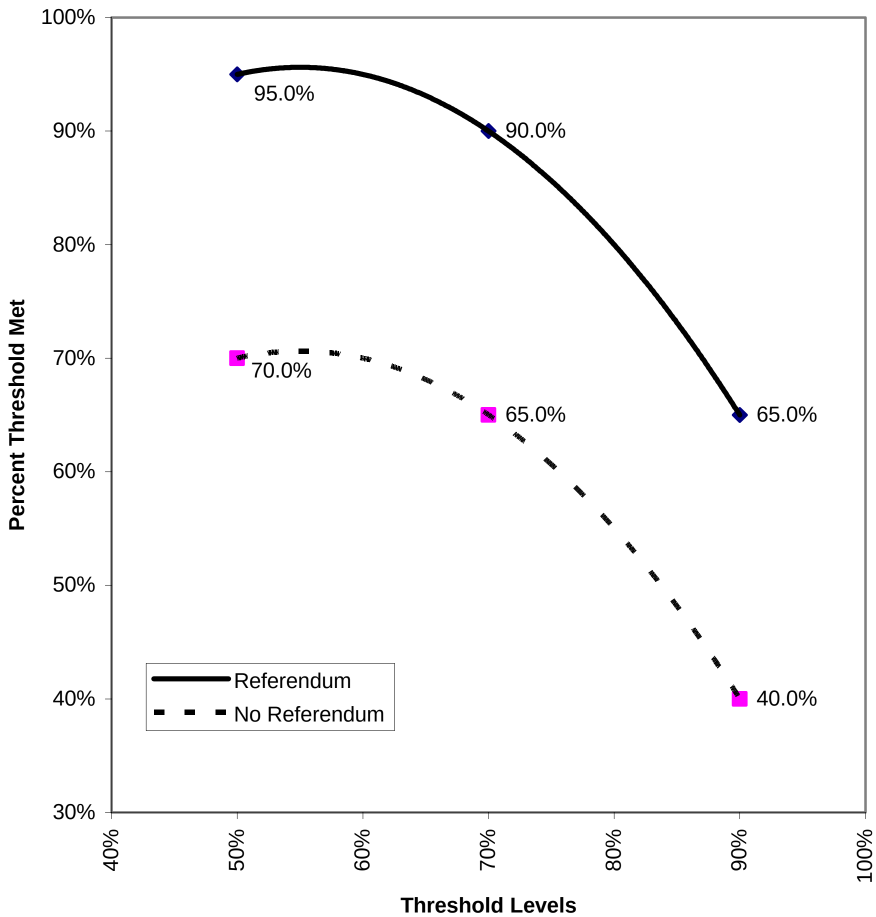

Figure 2. Percent Threshold Achieved (Benefit-Cost Ratio 4:1).

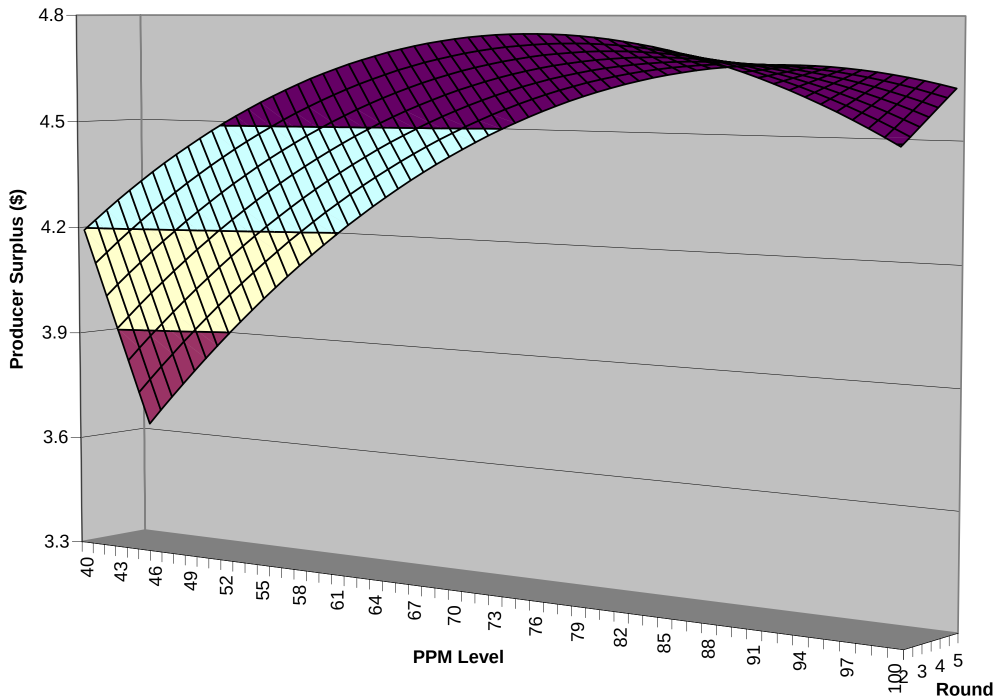

Figure 3. Predicted Subject Gross Surplus with Referendum (Benefit-Cost Ratio 4:1).

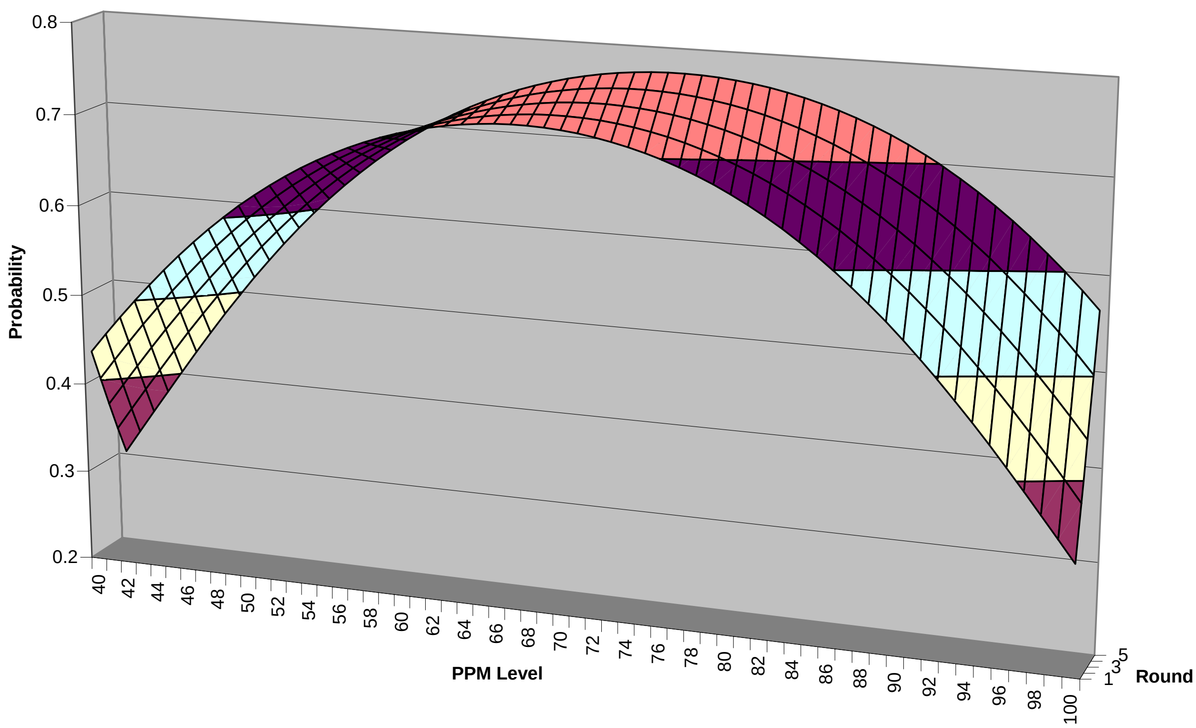

Figure 4. Predicted Subject Advertising Contribution Probability with Referendum (Benefit-Cost Ratio 4:1).

OTHER A.E.M. RESEARCH BULLETINS

RB No	Title	Fee (if applicable)	Author(s)
2004-11	Impact of Generic Milk Advertising on New York State Markets, 1986-2003		Kaiser, H., Wang, Y. and T. Schmit
2004-10	Consumer Preferences and Marketing Opportunities for Premium "Tree-Ripened Peaches" in New York State		Uva, W., Cuellar, S., and M. Cheng
2004-09	Agricultural Finance Markets in Transition; Proceedings of The Annual Meeting of NCT-194	($12.00)	Gloy, B., Editor
2004-08	Dairy Market Impacts of Milk Protein Imports and Trade Policy Alternatives		Bishop, P. and C. Nicholson
2004-07	The Coupon Report: A Study of Coupon Discount Methods		Park, K. and M. Gomez
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2004-05	Sweet Corn Marketing Channels in New York State -- A New York Sweet Corn Grower Survey		Uva, W.
2004-04	Optimal Seasonal Allocation of Generic Dairy Advertising Expenditures		Schmit, T. and H. Kaiser
2004-03	Status Quo Bias and Voluntary Contributions: Can Lab Experiments Parallel Real World Outcome for Generic Advertising?		Messer, K., Kaiser, H. and W. Schulze
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