Economic and Health Effects of Fruit and Vegetable Advertising: Evidence from Lab Experiments

Jura Liaukonyte  
Dake Family Assistant Professor of Marketing,  
Charles H. Dyson School of Applied Economics and Management  
Cornell University, Ithaca, NY 14853  
347 Warren Hall; phone: 607-255-6328;  
email: Jurate@cornell.edu

Bradley J. Rickard  
Assistant Professor,  
Charles H. Dyson School of Applied Economics and Management  
Cornell University, Ithaca, NY 14853  
255 Warren Hall; phone: 607-255-7417  
email: bjr83@cornell.edu

Harry M. Kaiser  
Gellert Family Professor,  
Charles H. Dyson School of Applied Economics and Management  
Cornell University, Ithaca, NY 14853  
350 Warren Hall; phone: 607-255-1598  
email: hmk2@cornell.edu

Abigail M. Okrent  
United States Department of Agriculture  
Economic Research Service  
phone: 202-694-5206  
email: aokrent@ers.usda.gov

Timothy J. Richards  
Morrison Chair, Morrison School of Agribusiness and Resource Management,  
W. P. Carey School of Business  
Arizona State University, Mesa, AZ 85212  
phone: 480-727-1488  
email: trichards@asu.edu
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ABSTRACT

This study investigates consumer response to various types of advertising for fruits and vegetables — a food category which health officials uniformly agree is significantly under-consumed in the United States. Using an adult, non-student subject pool of 271 participants in an economic experiment, consumers’ response to different types of fruit and vegetable advertising is measured empirically. This study finds that broad-based advertising, which is generic advertising for the entire fruit and vegetable category, increases consumer willingness to pay by an average of 24.6%. The simulation model shows that broad-based advertising for fruits and vegetables, either alone or as a hybrid with individual commodity-specific campaigns (e.g., apple advertising), would reduce average caloric intake per person by approximately 1,800 kcal per year. The results of this study may contribute to new public policy initiatives that aim to reduce diet-related illnesses and obesity, which have become increasingly prevalent in the United States.

Keywords: Food Marketing, Fruits and Vegetables, Obesity, Health Policy, Advertising.
1. INTRODUCTION

The United States has the highest obesity rate of any country in the world with 26.7% of the population being classified as obese (OECD Health Data, 2005; Doheny, 2010). Moreover, obesity rates have significantly increased: nearly doubling in adults and tripling in children in the past 30 years (Cutler et al., 2003; Hill et al., 2003; Grady, 2010). Some have called this increase a medical crisis (Hensrud and Klein, 2006). Medical science has shown that being obese or overweight poses significant health risk for serious diseases such as diabetes, heart disease, hypertension, stroke, and certain types of cancer (Andreyeva et al., 2004). A recent article indicates that the costs of this problem in the United States are immense, approaching $150 billion a year to deal with medical costs associated with these illnesses (Lillis, 2010).

A key factor mentioned for contributing to obesity is the steady decline in consumption of healthy foods like fruits and vegetables. Per capita fruit and vegetable consumption has declined by 12.5% and 7.6%, respectively, in the past 15 years (USDA, Economic Research Service, 2010). Health providers and nutritionists agree that reversing or mitigating this trend in fruit and vegetable consumption may be an effective means to lessen the obesity problem.

There are two types of advertising used to promote consumption of fruit and vegetables, defined generically: (1) “commodity-specific” programs for individual fruits and vegetables, e.g., the recent campaign for carrots (see http://www.babycarrots.com) and (2) “broad-based” programs that promote the consumption of all fruits and vegetables collectively (e.g., the voluntary U.S. program called Fruit and Veggies—More Matters campaign, the Australian Go for 2&5® campaign and the United Kingdom’s 5-A-Day campaign). However, expenditures on commodity-specific and broad-based advertising are just a fraction of the advertising budgets for less healthy foods. For example, food, beverage, candy and restaurant advertising was $11.26
billion in 2004, which is more than 100 times the advertising budget for fruits and vegetables, and this does not include the other (non-advertising) marketing expenditures for less healthy foods and beverages (CP-EHNCU, 2005).

Evidence in medical studies (Bazzano, 2006; Tohil, 2005) suggests that increasing fruit and vegetable consumption can be a successful dietary weight management strategy to prevent obesity by reducing overall energy density of the diet, promoting satiety, decreasing total energy intake, and increasing nutritional quality of a diet (Ledikwe et al., 2006; Rolls et al., 2004; Rolls et al., 2005). Also, empirical evidence suggests that a considerable amount of diet-related disease and associated health care costs can be prevented by a higher intake of fruits and vegetables (Gundgaard et al., 2003). The results of these studies have prompted the World Health Organization to target increasing fruit and vegetable consumption as a global public health nutrition priority (World Health Organization, 2003a; 2003b; 2004).

In this paper, we measure the impact of broad-based advertising, commodity-specific advertising, and two hybrid programs that include broad-based and commodity-specific advertising across eight selected fruits and vegetables. We use experimental methods to elicit consumers’ willingness to pay (WTP) for various fruits and vegetables subject to either broad-based or commodity-specific advertising. The WTP estimates based on the advertising treatments are used in an equilibrium displacement model of U.S. food demand to simulate the impact of fruit and vegetable advertising on consumption of ten food categories and on per capita caloric intake.

We are interested in three questions regarding the impact of broad-based and commodity-specific advertising on increasing demand for fruits and vegetables:
1) Would commodity-specific, broad-based, and/or hybrid advertising increase the demand for fruits and vegetables?

2) Which type of advertising would have the largest impact on fruit and vegetable demand?

3) What would be the impacts of the effective fruit and vegetable advertising programs on caloric intake?

Using an adult, non-student subject pool of participants in the economic experiment, we empirically measure how consumers respond to different broad-based and commodity-specific advertising campaigns for various fruits and vegetables.

The experiment developed in this paper allows us to shed some new light on the influence of advertising on fruit and vegetable consumption, and on combating obesity. We employ a simulation model in the analysis and are able to show the potential links between advertising programs, demand responses for fruits, vegetables, and other food groups, and changes in calories consumed in the United States. This paper also provides results that contribute to the literature examining the economic effects of generic advertising in several ways. First, very few studies have used experimental economics to evaluate consumer response to promotional efforts for agricultural products (a notable exception is Messer et al., 2009). Second, our research is the first to empirically measure the economic effects of both broad-based advertising and commodity-specific advertising. There have been numerous studies that have measured the market impacts of commodity-specific campaigns (e.g., Kaiser et al., 2003), but the economic effects of broad-based advertising campaigns have not been studied in detail. In addition, no study has investigated the efficacy of the two advertising approaches simultaneously or researched broad-based advertising effects with Americans. Finally, a non-hypothetical experiment, in which consumers respond to real economic incentives, is better able to replicate
the real-world decision process than mere surveys or choice experiments (Friedman and Sunder, 1994; Rubinson, 2010).

The broader objectives of this paper are to provide empirical evidence on the relative effectiveness of broad-based and commodity-specific advertising and the potential effects of such promotional campaigns on obesity rates in the United States and to add some substance to the current debate in the industry.

While this research has some real world applicability limitations, the magnitude of our laboratory experiment results is largely consistent with the magnitude of the field findings of Pollard et al. (2008), who find that a broad-based advertising campaign in Australia resulted in an increase in fruit and vegetable consumption. The similarity of findings reinforces our confidence that our results have a capacity to be generalized to real world settings and to help guide policy debate.

2. OVERVIEW OF FRUIT AND VEGETABLE PROMOTION EFFORTS

How best to increase fruit and vegetable consumption is, of course, a difficult question. Of the marketing tools offered by Goldberg and Gunasti (2007), promotion—or the relative lack thereof—is often suggested as the primary barrier to increasing fruit and vegetable consumption.

Research has examined the consumption effects of broad-based promotion programs for fruits and vegetables in Australia (Pollard et al. 2008) and in the United Kingdom (Capacci and Mazzocchi 2011). Australia implemented a large-scale broad-based advertising campaign between 2002 and 2005 titled “Go for 2&5”, and research by Pollard et al. (2008) shows that it did increase adults’ awareness of the nutritional benefits of eating more fruits and vegetables. Furthermore, the Australian program is estimated to have increased consumption of the mean
number of servings of fruits and vegetables by 0.8 servings per day over the three-year period when the advertising occurred (Pollard et al., 2008). Other research by Capacci and Mazzocchi (2011) disentangles information and price effects related to the 5-A-Day program in the United Kingdom; they found that the broad-based program increased fruit and vegetable consumption by between 0.2 and 0.7 portions per person using data between 2002 and 2006.

The U.S. fruit and vegetable industry has recently considered whether they should adopt a mandatory broad-based advertising for all produce marketed in the country in addition to the many commodity-specific programs that currently exist (National Fruit and Vegetable Research and Promotion Board, 2009). Whether commodity-specific or broad-based advertising efforts would lead to greater sales of fruits and vegetables has been widely debated among industry stakeholders (see Prevor, 2009), and there is no clear consensus among growers and packers on this issue. Some producers see commodity-specific programs competing with other commodity-specific programs for consumers’ attention in a destructive game of advertising competition, whereas broad-based programs have the capacity to increase sales for all fruits and vegetables. Along similar lines, many industry stakeholders see various commodity-specific programs competing for the fixed quantity of fruits and vegetables that will be consumed; in this case, commodity-specific programs compete for a fixed amount of “stomach share” among consumers rather than trying to expand the total amount of fruit and vegetable consumption. Others in the industry are less supportive of broad-based advertising because the central message in these programs simply emphasizes an already well-known fact—that eating a diet rich in fruits and vegetables is good for your health—and believe that such promotion efforts will have little impact on the demand for these products.

Two other important issues in this debate revolve around the particular funding
mechanisms for a broad-based advertising program. The first centers on which commodities would participate in such a program, and if the program should be limited to only fresh products (or also include processed fruit and vegetable products). Second, there has been an on-going discussion among stakeholders regarding who should pay for a broad-based advertising program. Given that there are potentially positive outcomes to both public and private interests, it is not clear what should be the relative contributions from industry and from the government, if any. Similar programs in Australia, Canada, and the United Kingdom receive some government support to conduct broad-based promotion efforts for fruits and vegetables. It is possible that such a program could lead to benefits for growers of fruits and vegetables (given the possibility of increased demand and higher revenues). It is also possible that a broad-based program will increase the share of fruit and vegetable consumption, which are considered to be healthy food choices, and this has the capacity to lead to positive outcomes for society more generally. There is another ongoing discussion concerning the products that should be included in such a program.

3. METHODOLOGY

3.1 Experiment Design

A total of 271 adult, non-student subjects participated in the experiment, which measured WTP response to alternative broad-based and commodity specific advertisements. First, subjects viewed three 90-second episodes of The Simpsons (a popular animated television show), which were originally broadcasted as part of the Tracey Ullman Show in the late 1980s. All subjects except those in the control group also viewed four 30-second fruit and vegetable advertisements with two shown between the first and second Simpsons episode and the other two shown between the second and third Simpsons episode. Second, subjects were asked to bid in auctions
for four fruits and four vegetables. The experiment took just under one-hour and subjects earned $25 in cash and/or groceries.

Subjects were randomly assigned to one of six treatments. The control group (Treatment 1) included 58 subjects who were not exposed to any advertisements, but did view three 90-second episodes of The Simpsons. The broad-based advertising treatment (Treatment 2) included four 30-second advertisements for fruits and vegetables from the Australian “Go for 2&5” and the United Kingdom “5-A-Day” campaigns. The 41 subjects in this treatment watched all three Simpsons and all four broad-based advertisements before the auction. Two commodity-specific treatments were included featuring apple advertising (Treatment 3) and potato advertising (Treatment 5). Apples and potatoes were chosen for the commodity-specific treatments because each are important commodities in terms of consumption and value (USDA-NASS, 2011). We chose not to include other commodity specific treatments because subjects may interpret a series of advertisements for specific fruits and vegetables as a broad-based campaign, which would make it difficult to disentangle commodity-specific from broad-based advertising effects.

Treatment 3 had 44 subjects who viewed the Simpsons clips and three 30-second advertisements for New York State apples and one 30-second advertisement for Washington State apples. Treatment 5 (n=42) subjects viewed four 30-second Idaho potato advertisements in addition to the Simpsons. Finally, two hybrid broad-based, commodity specific treatments were included. Treatment 4 (n=38) featured two 30-second apple (one Washington and one New York State) advertisements and two 30-second broad-based advertisements between the Simpsons clips, and Treatment 6 (n=48) consisted of two 30-second potato and two 30-second

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1 We started with a list of about 20 different fruits and vegetables and, in the end, narrowed it down to 8. Our decision was mostly based on certain fruit and vegetable availability in a traditional grocery store and on consumer consumption patterns (we selected widely and frequently consumed items) in the United States. We also wanted to include a range of items so that at least some would appeal to all subjects.
broad-based advertisements. For each of these treatments, the broad-based advertisements included one Australian and one United Kingdom advertisement.

3.2 Auctions

After viewing the media clips, subjects were taught how the auctions worked. To elicit maximum WTP for each auctioned item, a computerized sealed first price auction was used. This type of auction was chosen because it is easy for subjects to learn and because research has shown it is demand revealing (Elyakime, et al., 1994; Kagel, 1995). To teach subjects the basic mechanics of the auction, a practice round was included where subjects submitted bids for a pen. In the practice round, subjects started a computer clock with their bids beginning at $0.00 and increasing in $0.10 increments every two seconds until they hit the withdraw button or the bid reached $2.00, which was the maximum bid for the pen.

After learning the auction for the pen, eight auctions for fruits and vegetables were conducted with the bid clock ranging from $0.00 to a maximum of $6.00, increasing by $0.10 increments every two seconds. The eight commodities included one pound each of apples, oranges, bananas, table grapes, carrots, red bell peppers, Russet potatoes, and tomatoes, and the order of the auctions was randomized for each session. Before the auctions, participants were told that the grocery items were recently purchased from a local supermarket and none were organically produced. To maintain an incentive compatible experiment, we told participants that the highest bidder for each item may end up purchasing the item with the purchase price equal to their bid. Because subjects could place a bid of up to $6.00 per item, we did not want the value of their bids to exceed their $25 participation endowment. Therefore, to prevent this type of budget constraint on subjects’ bidding activity, participants were informed that only one-half of
the auctions would result in an actual transaction, and that these auctions would be randomly chosen at the end of the experiment. In practice, none of our subjects placed a bid of $6.00 for any of the commodities, so no one approached this type of budget constraint. The highest bidder for each item was not announced until all auctions were concluded.

After all auctions were finished, participants completed a computerized questionnaire eliciting their attitudes towards the advertisements in the experiment, likeability of fruits and vegetables, and demographic information such as weight, height, age, income, and education. To examine the persuasiveness component of advertising programs in our experiment and to control for whether the quality of advertisements influences the changes in WTP across the treatments, we asked participants to evaluate advertisements on a scale from 1 to 5. The complete list of survey questions that were asked in the experiments together with other experiment materials are included in the Supplementary Appendix.

4. EXPERIMENT DATA ANALYSIS AND RESULTS

The key demographic information for the subjects across all treatments in our sample, summarized in Table 1, is very similar to data collected in national shopping behavior surveys (e.g., Food Marketing Institute, 2006; Grocery Shopping Network, 2011), leading us to believe that our sample is reasonably representative of the U.S. grocery shopping population.

Table 2 shows the average overall WTP across treatments for the fruits and vegetables included in the experiment; it also shows the average WTP for each commodity in each treatment. All of the treatments that included broad-based advertising (treatments 2, 4 and 6) have WTP averages that are statistically significantly higher than the control. Table 2 also shows that overall WTP averages for treatments exposed to the apple and potato commodity-specific
advertising programs were approximately the same as the control. WTP for the advertised commodities (apples for treatment 3, and potatoes for treatment 5) also were not statistically different than WTP for those commodities in the control group.

<Insert Table 1 about here>

<Insert Table 2 about here>

Theoretically, WTP measures the maximum an individual is willing to pay to acquire an item. Therefore, WTP can be used to construct demand curves by calculating and plotting the percentage of individuals with WTP greater than particular price levels (Lusk and Hudson, 2004). The resulting demand curves are represented in Figure 1. In general, these figures represent the same patterns that are apparent in the descriptive statistics table, just graphically. The demand curves for all fruits and vegetables with broad-based advertising are significantly higher than the control group’s demand curve for all fruits and vegetables. However, the demand curves with commodity specific advertising are not significantly different from the control group’s demand curve.

<Insert Figure 1 about here>

Next, we present a more rigorous analysis that estimates the effects of commodity-specific and broad-based advertising on the WTP for fruits and vegetables, and it accounts for all of the demographic variables listed in Table 1. Since participants in the experiments were allowed to submit zero bids for auctioned items (as indicated in Table 1, depending on the treatment, approximately 12 to 20% of the observations were zero bids), we estimate the following linear regression Tobit model for left-censored dependent variables:

\[
\begin{aligned}
WTP_{itj}^* &= \alpha_t + \beta_t \text{Treat\_dummy}_t \cdot \hat{Q}_{it} + \sum_l \gamma_l x_{ilt} + \varepsilon_{ijt}, \\
WTP_{itj} &= \max (WTP_{itj}^*, 0).
\end{aligned}
\]
Here, subscript $i$ refers to an experiment participant, $j$ to the commodity (apples, bananas, carrots, grapes, oranges, peppers, potatoes, tomatoes, or all fruits and vegetables) and $t$ to experiment treatment. The constant is denoted as $\alpha_t$, \( \text{Treat\_dummy}_t \cdot \hat{Q}_{it} \) is the advertisement quality-adjusted treatment dummy variable, $\gamma_{lt}$ represents the marginal effect of demographic attribute $l$ (listed in Table 1) on WTP in treatment $t$, $x_{lit}$ is demographic attribute $l$ for individual $i$ in treatment $t$, and, finally, the error term is $\varepsilon_{ijt} \sim N(0, 1)$.

To examine the persuasiveness component of advertising programs in our experiment and to control for whether the quality of advertisements influences the changes in WTP across the treatments, we weight the treatment specific dummies by the advertising quality variables, $Q_{it}$. In the cases where both commodity-specific and broad-based advertising were shown, we constructed the $Q_{it}$ by averaging the self-reported advertisement likeness variable across the two types of advertisements. It is important to note that the elicited bid and advertising likeness variables are determined simultaneously and therefore $Q_{it}$ is endogenous. Following the standard econometric procedures, we deal with the endogeneity issue by instrumenting $Q_{it}$ with individual-specific exogenous demographic characteristics (such as sex, race, education, income, etc.) to get $\hat{Q}_{it}$. The complete list of the instrumental variables can be found in Table 1 (excluding the endogenous advertisement quality variables).

Table 3 presents the results obtained by estimating the Tobit model. The coefficients in the first six rows describe the difference between the advertising quality-weighted WTP, which is associated with the presence of a marketing activity, and the control treatment, where no advertisements were shown. The results in Table 3 reiterate the patterns depicted with the demand curves in Figure 1: only treatments with broad-based advertising (treatments 2, 4 and 6)
have statistically significant positive effects. Treatment 2 is statistically significant at 5% level, whereas treatments 4 and 6 are statistically significant at 1% level (t-values are 2.49, 4.47 and 3.29 respectively).

Bids from subjects exposed to commodity-specific advertising are different from those in the broad-based treatment. The estimated commodity-specific treatment effects are not statistically significant. Therefore we conclude that the broad-based advertising effect outweighs the commodity-specific advertising effect as treatments that combine commodity-specific advertising and broad-based advertising appear to generate results that are closer to the broad-based results. We also estimated a more restricted commodity-specific advertising effect specification: we allowed the effect of commodity-specific advertising to be only on advertised commodities, i.e. on apples for treatment 3 and potatoes for treatment 5. We found no statistically significant commodity-specific advertising effects under this restricted specification; however, we expect this insignificant result is partly due to the low number of bids observed for apples and potatoes in these treatments. Related research by Rickard et al. (2011) uses the same data and finds that consumer demand becomes slightly more inelastic after commodity-specific advertising exposure; however, they do not find any demand increase as a result of commodity-specific advertising. For the remainder of the paper we will assume that the commodity-specific advertisements did not influence consumers’ WTP for the selected fruits and vegetables, and that the effects for treatments with commodity-specific advertising were equal to zero.

The interpretation of the marginal effects of the estimated treatment fixed effects is more intuitive when evaluated at a constant advertising quality level (in this case, the mean quality level summarized in column 3 of Table 3). Column 4 in Table 3 depicts monetary WTP changes associated with treatments 2 (Broad-Based advertisements only), 4 (Hybrid advertisements:
Broad-Based + Apples) and 6 (Hybrid advertisements: Broad-Based+Potatoes). After controlling for demographics and attitudes towards advertising, on average, participants exposed to broad-based advertising bid 14 cents higher than participants in the control group whereas the average differences for hybrid treatments with apple and potato advertisements were 24 and 17 cents higher, respectively. In percentage terms, treatments with broad-based advertisements and hybrid advertisements resulted in an average increase in WTP of 18.1%, 32.8%, and 22.9% respectively (and an overall average of 24.6%). Several of the demographic and attitudinal variables also had a significant impact on WTP for the fruits and vegetables in our experiment. As indicated in Table 3, gender, income, race, education, BMI, having children, being aware of 5-A-Day campaign and buying conventional vegetables have significant effects on WTP for fruits and vegetables. Males and Asian participants were found to bid less, whereas higher education, income and BMI, 5-A-Day awareness and buying conventional (not organic) vegetables and fruits translated into higher bid levels.

Given the WTP data points before and after an advertisement campaign, the change in WTP ($\Delta WTP$) can be interpreted as the vertical shift in the demand curve due to the campaign. The corresponding horizontal shift, $\Delta Q_t$, is measured as the product of the vertical shift, $\Delta WTP$, and the own-price elasticity of demand: $\eta_t \cdot \Delta WTP_t = \Delta Q_t$ (Carpio and Isengildina-Massa, 2010). Since we can back out the horizontal and vertical shifts in the demand curve from data collected in the experiments, we can calculate the implied price elasticity for fruits and vegetables in the treatments with broad-based advertising. We calculate the implied elasticity for treatments with broad-based advertising at three points of the demand curve: at the 25th and 75th percentiles and the median). The elasticity results are presented in the last three columns of Table 3. The median implied elasticities for these three treatments range between -0.59 to -0.55
and are close to empirical fruit and vegetable elasticities found in the literature. For example, Okrent and Alston (2011) estimate the own-price elasticity for fruits and vegetables to be -0.58, whereas Huang and Lin (2000) estimate the value to be -0.77, which is slightly more elastic than our implied estimate, but fairly close. Hence, the consistency of the implied elasticities of demand from our analysis with estimates of elasticities of demand from the literature reinforces our WTP results.

Based on these experimental results, broad-based advertising, either alone or coupled with existing commodity-specific advertising, has a significant impact on fruit and vegetable demand. At the same time, the two commodity-specific advertising campaigns examined have no impact on overall fruit and vegetable demand. Since the fruit and vegetable sector currently relies almost exclusively on commodity-specific advertising, a key implication of this research is that a switch to either an exclusive or a hybrid broad-based advertising program would have a larger impact on overall demand. These results should be thought of as an upper bound estimate of the true impacts of these advertisements on consumer WTP since they were obtained in the lab under controlled conditions. In the real world, consumers are exposed to a lot of noise such as other advertisements, which could dampen the impact of the advertisements on consumer demand. Nevertheless, our estimates for changes in WTP under the broad-based program are surprisingly similar to the results from the recent campaign in Australia (as reported in Pollard et al. 2008), and this leads us to believe that our findings may be close to actual, real world results if the campaigns were adopted under similar scope conditions as in Australian field experiment.

5. **EXAMINING POTENTIAL LINKS BETWEEN BROAD-BASED PROMOTION AND OBESITY**
Research has indicated that advertising is important in creating social norms and promoting healthy eating practices, especially for groups of consumers nutritionally at risk (Story and Faulkner, 1990). Television, a medium that reaches millions of people for hours each day, is ideal for presenting positive health-related images and nutritional information (Avery et al., 1997). However, the frequency of health claims reported in advertising content studies has been small, ranging from 1% to 3% of advertisements (Teisl et al., 1999). In terms of achieving the desired effect, the public advertising message content is also important. Briley and Aaker (2006) argue that certain target groups would be more persuaded by a positive promotion strategy, i.e. health appeal that focuses on the potential benefits gained by adopting better eating habits (such as eating more fruits and vegetables) than by a negative prevention strategy, i.e., health appeal that focuses on problems to be avoided (such as keeping off extra weight).

We simulate the potential effects of the fruit and vegetable promotion strategies on food consumption using an equilibrium displacement model developed by Okrent and Alston (2012). Following Okrent and Alston (2012), we model the market equilibrium for a system of \( N \) demand equations for food products, \( N \) total cost equations for food product supply, \( L \) supply equations for input commodities and \( L \times N \) equations for competitive market clearing as:

\[
\begin{align*}
(1) \quad Q^n &= Q^n(P^n, A^n), \forall n = 1, \ldots, N, \\
(2) \quad P^n &= c^n(W), \forall n = 1, \ldots, N, \\
(3) \quad X_l &= \sum_{n=1}^{N} g_{l}^{n}(W) Q^n, \forall l = 1, \ldots, L, \\
(4) \quad X_l &= f_l(W, B_l), \forall l = 1, \ldots, L.
\end{align*}
\]

Equation (1) represents the demand for \( n \)th food product in which the quantity demanded, \( Q^n \), is a function of an \( N \times 1 \) vector of product prices, \( P \), and an exogenous demand shifter, \( A^n \),
which subsumes the effects of changes in total consumer expenditure and other exogenous shifters on product demand.\textsuperscript{2} Equation (2) is based on the assumption of constant returns to scale at the product industry level and competitive market equilibrium, where the price of the \( n \)th product is set equal to the marginal cost of producing product \( n \), \( c^n(W) \), which is a function of an \( L \times 1 \) vector of commodity prices, \( W \) (Alston, Norton, and Pardey 2004).\textsuperscript{3} Equation (3) is the Hicksian demand for commodity \( l \), \( X_l \), which is derived from applying Shephard’s lemma to the total cost functions of the \( N \) products (i.e., \( \partial C^n/\partial W_l = g^n_l(W)Q^n \) ) and then summing across the \( N \) product industry demands for commodity \( l \).\textsuperscript{4} Equation (4) is the supply function for commodity \( l \), which is a function of all of the commodity prices and an exogenous supply shifter, \( B_l \). Totally differentiating equations (1)–(4), and expressing these equations in relative change terms (i.e., using \( dX_i/X_i = EX_i \) ) yields

\[
\begin{align*}
(5) \quad EQ^n &= \sum_{k=1}^{N} \eta^{nk} E P^k + a^n, \forall n = 1, \ldots, N, \\
(6) \quad EP^n &= \sum_{l=1}^{L} \frac{\partial c^n(W)}{\partial W_l} \frac{W_l}{P^n} EW_l, \forall n = 1, \ldots, N, \\
(7) \quad EX_l &= \sum_{n=1}^{N} SC^n_l \sum_{m=1}^{M} (\eta^{nl}_m EW_m + EQ^n), \forall l = 1, \ldots, L,
\end{align*}
\]

\textsuperscript{2} Superscripts on variables denote products, and the subscripts denote the farm commodities and composite marketing input. For the rest of this article, the term ‘commodities’ refers to both farm commodities and the composite marketing input.

\textsuperscript{3} Suppose the technology for the industry producing product \( n \) can be expressed as a total cost function in which the total cost of producing the \( n \)th retail product, \( C^n \), is a function of an \( L \times 1 \) vector of prices of farm commodities and the marketing input, \( W \), and the quantity of the product, \( Q^n \), i.e. \( C^n = c^n(W)Q^n \). Under the assumption of constant returns to scale, the average cost per unit of product \( n \) is equivalent to its marginal cost (i.e., \( C^n/Q^n = c^n(W) \)), and, under the further assumption of competitive market equilibrium with no price distortions, marginal cost and average cost are equal to the retail price, \( P^n \).

\textsuperscript{4} Note that totally differentiating equation (3) yields

\[
dX_i = \sum_{n=1}^{N} \sum_{m=1}^{M} \frac{\partial g^n_l(W)}{\partial W_m} Q^n dW_m + \sum_{n=1}^{N} g^n_l(W) dQ^n.
\]

Expressing this in relative change terms (i.e., using \( dX_i/X_i = EX_i \) ) is

\[
EX_i = \sum_{n=1}^{N} \sum_{m=1}^{M} SC^n_l \eta^{nl}_m EW_m \sum_{n=1}^{N} g^n_l(W) \frac{Q^n}{X_i} EQ^n.
\]

From Shephard’s lemma, \( x^n_l = g^n_l(W)Q^n \), and substituting \( x^n_l \) into the above and multiplying by \( W_l/W_l \) yields equation (7).
where:

\[ \eta^{nk} = \frac{\partial Q^n(P, A^n) P^k}{\partial P^k} Q^n \]

is the Marshallian elasticity of demand for retail product \( n \) with respect to retail price \( k \)

\[ SC^n_l = \frac{X^n_l W_l}{X^n_l W_l} \]

is the share of the total cost of commodity \( l \) across all industries used by retail product \( n \) (farm-commodity share)

\[ \eta_{lm}^* = \left( \frac{\partial g^n_l(W) Q^n}{\partial W_m} \right) W_m X^n_l \]

is the Hicksian elasticity of demand for commodity \( l \) in industry \( n \) with respect to commodity price \( m \)

\[ \varepsilon_{ij} = \left( \frac{\partial f_l(W, B_i)}{\partial W_j} \right) W_j X^n_l \]

is the elasticity of supply of commodity \( l \) with respect to commodity price \( j \)

\[ \alpha^n = \frac{\partial Q^n(P, A^n) A^n}{\partial A^n} X^n_l \]

is the proportional shift of demand for retail product \( n \) in the quantity direction

\[ \beta_l = \left( \frac{\partial f_l(W_l, B_l)}{\partial B_l} \right) B_l X^n_l \]

is the proportional shift of supply of commodity \( l \) in the quantity direction

Several simplifications can also be made to the system. First, since \( \frac{\partial c^n(W)}{\partial W_l} = X^n_l / Q^n \), equation (6) can be rewritten as

\[ EP^n = \sum_{l=1}^{L} SR^n_l EW_l, \forall n = 1, ..., N, \]

where \( SR^n_l = X^n_l W_l / P^n Q^n \) and is the share of total cost for retail product \( n \) attributable to commodity \( l \) (farm-retail cost share). Second, the share-weighted Hicksian elasticity of demand for commodity \( l \) with respect to the price of commodity \( m \) is

\[ \eta_{lm}^* = \sum_{n=1}^{N} SC^n_l \eta_{lm}^*. \]

Equation (7) can be rewritten using (16):

\[ EX_l = \sum_{m=1}^{M} \eta_{lm}^* EW_m + \sum_{n=1}^{N} SC^n_l EQ^n, \forall l = 1, ..., L. \]

Furthermore, under an assumption of fixed proportions, the Hicksian elasticity of demand between two factor inputs \( l \) and \( j \) in product \( n \) is zero (i.e., \( \eta_{lj}^* = 0, \forall l = 1, ..., L, \forall n = 1, ..., N \), which implies:
Lastly, the assumption of exogenous commodity prices (i.e., representing the case where the U.S. food industry faces a perfectly elastic supply of farm commodities, including supply from storage and reflecting the influence of international trade) implies that equation (8) becomes

\[
EW_l = \bar{\beta}_l,
\]

where \( \bar{\beta}_l \) is a proportionate shift in supply of commodity \( l \) in the price direction.\(^5\)

To simplify the notation, we present equations (5), (15), (18) and (19) in matrix notation. Letting \( EQ \), and \( EP \) be \( N \times 1 \) vectors of proportionate changes in quantities and prices of retail products, respectively, and \( EX \), and \( EW \) be \( L \times 1 \) vectors of proportionate changes in quantities and prices of commodities, respectively, the system is

\[
\begin{bmatrix}
I^N & -\eta^N & 0 & 0 \\
0^N & I^N & 0 & -SR \\
-SC & 0^T & I_L & -0_L \\
0^T & 0^T & 0^T & -I_L
\end{bmatrix}
\begin{bmatrix}
EQ \\
EP \\
EX \\
EW
\end{bmatrix}
= \begin{bmatrix}
\alpha \\
0 \\
0 \\
\beta_l
\end{bmatrix}
\]

where the parameters are defined above. Using matrix block inversion, the solutions for \( EQ \), \( EP \), \( EX \) and \( EW \) are:

\[
\begin{align*}
\text{Note that } & \varepsilon_{ll} = \varepsilon_{ll} \left( \frac{\partial W_l}{\partial B_l} \right) \frac{\bar{\beta}_l}{W_l} \text{ or } \beta_l = \varepsilon_{ll} \bar{\beta}_l. \text{ Hence, becomes (8)} \\
EX_l &= \sum_{m=1, m \neq l}^M \varepsilon_{lm} EW_m + \varepsilon_{ll}(EW_l + \bar{\beta}_l). \\
The limit of this equation as } \varepsilon_{ll} \to \infty \text{ is} \\
\lim_{\varepsilon_{ll} \to 0} \left[ \frac{1}{\varepsilon_{ll}} (EX_l - \sum_{m=1, m \neq l}^M \varepsilon_{lm} EW_m) \right] &= \lim_{\varepsilon_{ll} \to 0} \left[ \frac{1}{\varepsilon_{ll}} (EW_l + \bar{\beta}_l) \right] = EW_l + \bar{\beta}_l.
\end{align*}
\]

\(^5\)
We used several data sources to parameterize (21) for the shift in demand for fruits and vegetables induced by the advertising promotions. First, we use elasticities of demand ($\eta^N$) for eight food-at-home (FAH) products (i.e., cereal and bakery products, red meat, poultry and eggs, fish and seafood, dairy products, fruits and vegetables, other FAH, including packaged and frozen foods), a food-away-from-home (FAFH) composite (i.e., all foods purchased at restaurants, vending machines, mobile vendors, and employee and school cafeterias), and alcoholic beverages from Okrent (2010). Second, the farm-retail product ($SR$) and farm-commodity ($SC$) shares are derived from the 2002 Benchmark Input-Output Detailed Use Table (Department of Commerce, Bureau of Economic Analysis 2007). Third, to parameterize the shift in demand for fruits and vegetables from promotion $t$ ($\alpha^{\text{f&v}}_t$), we interpret the rate of change in $\Delta WTP_t$ as the vertical shift in the demand curve due to the promotion $t$ (Carpio and Isengildina-Massa 2010). Hence, the corresponding horizontal shift or shift in demand in the quantity direction is measured as the product of the vertical shift ($\Delta WTP_t$) and the own-price elasticity of demand for fruits and vegetables ($\eta^{f&v,f&v}$):

$$\alpha^{\text{f&v}}_t = -\Delta WTP_t \times \eta^{f&v,f&v}.$$  

Also, we assume that the demand for other foods in our analysis are also affected by the fruit and vegetable promotion, which implies that the cross-promotional effects are

---

6 See Okrent (2010) for more details.
Lastly, the simulated changes in quantities of retail food products are translated into changes in daily and annual calories consumed using the average daily quantity of food and energy intake reported in the 2005-06 National Health and Nutrition Examination Surveys (NHANES) for individuals aged 18 and older (Centers for Disease Control and Prevention, National Center for Health Statistics 2008). Data in the 2005-06 NHANES categorize foods based on the United States Department of Agriculture (USDA) food classification system and we aggregated the detailed foods so that they closely match the food products included in our simulation model.

\[ \alpha_{t}^{other\,foods} = -\Delta WTP_t \times \eta_{t}^{other\,foods,f&v}. \]

We performed three simulation experiments to better understand how the fruit and vegetable promotion strategies that included broad-based advertisements would potentially affect food consumption, and annual per capita caloric intakes. The simulation exercise can be thought of as a “calorie calculator” for a given change in demand for the fruit and vegetable food category considering all of the cross category responses. We chose to simulate the effects of three changes in demand for fruits and vegetables based on our WTP estimates. Overall, we find that introducing a smaller (larger) demand shock for fruits and vegetables due to advertising leads to proportionally smaller (larger) effects of food consumption and caloric intake. Table 4 presents the food consumption and caloric impacts from adoption of three different broad-based promotion strategies for fruits and vegetables that were analyzed here (i.e., broad-based advertising, broad-based coupled with apple advertising, and broad-based coupled with potato advertising). We do not include simulation results for the commodity-specific advertising efforts as the econometric findings did not show any statistically significant relationship between advertising and subjects’ WTP.
The top portion of Table 4 describes the simulated changes in prices and quantities of the 10 food categories for an exogenous demand shock for fruits and vegetables due to advertising. The exogenous shocks are modeled as vertical shifts in demand and calculated using the estimated effects from advertising listed in Table 3. Specifically, in the results for broad-based advertising we model the effects of a 18.1% change in the WTP for fruits and vegetables, for broad-based plus apple advertising we model the effects of a 32.8% change in WTP, and for broad-based plus potato advertising we model the effects of a 22.9% change in WTP. We also report the results from a 24.6% change in WTP which represents the average change across our treatments that included broad-based advertisements.

Table 4 provides an indication of the effects that successful advertising programs for fruits and vegetables might have on obesity rates. However, because our data were collected in a lab setting, and because subjects were not exposed to other advertisements in our experiment, the results in Table 4 should be interpreted with caution. We should also note that we did not model consumer heterogeneity in terms of their initial fruit and vegetable consumption levels, for the sake of model tractability and we interpreted the results as if the average consumer’s fruit and vegetable consumption levels rose at the levels consistent with our experiment estimates. The results in Table 4 suggest that all three types of advertising will slightly increase the consumption of poultry and eggs, fish and seafood, dairy and other food category and decrease consumption of cereals and bakery, red meats, nonalcoholic beverages and food away from home. The promotion efforts appear to have very little effect on the consumption of alcoholic beverages. Because food categories cereals and bakery, red meats, nonalcoholic beverages and food away from home are relatively calorie dense, these changes would lead to an overall decrease in energy consumption in the range of 1,328 to 2,408 calories per person per year or a
decrease of 0.48 to 0.84 pounds per person. These changes are equivalent to a 0.50% to 0.85% change in body weight, and represent non-trivial changes.

The average American has gained 16.3 pounds during the 21 years (1988–2008) which results in an average weight gain of 0.77 pounds annually (United Health Foundation, 2008). Obesity is a dynamic process, and many have argued that obesity is a problem that emerges slowly over the course of adulthood (e.g., Hill et al., 2003). Therefore, it is likely that successful solutions to the obesity problem will also occur gradually over time (Wang et al. 2012). If fruit and vegetable marketers followed an advertising approach that adopted broad-based advertising, it would reduce overall caloric intake of around 1,800 calories per person annually, and this would be equivalent to a per capita weight reduction of approximately 0.65 pounds in a steady state. Our calculations do not take into account important factors such as nonlinear weight gain, changes in metabolism, which often cause difficulty to lose weight.

6. **FINAL REMARKS**

6.1 **Summary of Research Findings**

There is a significant body of literature examining the causes of obesity and documenting the related health and monetary costs. In this article, we examine one of the potential causes in the United States, the negligible amount of advertising used to promote fruits and vegetables relative to unhealthy food groups, and look at how a well-developed advertising campaign might influence fruit and vegetable consumption. By using experimental methods, we investigate the effectiveness of two different types of advertising used for such products – broad-based and commodity-specific.
We find strong support that broad-based advertising has a significantly higher effect than commodity-specific advertising on consumers’ WTP for fruits and vegetables. Our results are consistent with the findings of broad-based advertising program field experiment implemented over a three-year (2002-2005) period in Australia. The Go for 2&5 promotional campaign included a wide range of marketing activities, including television, radio, and print advertisements, point-of-sales promotions, public relations campaigns, nutritional school activities, and a website (Pollard et al., 2008). Our results, and the findings on the Australian program, suggest that both industry stakeholders and government health agencies should carefully consider adopting a broad-based promotional strategy.

Our research provides the first piece of empirical evidence about the broad-based advertising effects relative to commodity-specific. While our research has some limitations, it is an important starting point in a significant industry debate in the United States. The fruit and vegetable sector in the United States currently has a voluntary broad-based program that is significantly smaller than the Go for 2&5 broad-based program used in Australia. The U.S. industry has discussed adopting a mandatory broad-based program that would be used in addition to the current set of commodity-specific programs. In 2009, advocates of a mandatory program proposed to assess first handlers of all fruits and vegetables an annual per-unit tax in order to raise $30 million for broad-based advertising. However, for various reasons, the majority of growers did not want to adopt the proposed program and the United States continues to employ a relatively small voluntary program.

Broad-based advertising has the capacity to increase demand for fruits and vegetables, and it also has the capacity to decrease caloric consumption. A recent study by Wang et al. (2012) calculates that, on average, a 64 kcal/day reduction is needed within youth population to
prevent future obesity. Some of this caloric reduction can come simply from switching the daily diet composition to include more fruits and vegetables. Our study finds that a successful broad-based advertising campaign for fruits and vegetables, either alone or as a hybrid with commodity-specific campaigns, would reduce average annual caloric intake per person by approximately 1,800 kcal. Such a strategy could be used as one component of an overall program to reduce obesity and the serious health risks associated with it.

Our model is able to quantify caloric changes of a diet with any increased level of consumption of fruits and vegetables, which might underestimate the actual health effects of consuming more fruits and vegetables. Higher consumption of fruits and vegetables implies higher levels of vitamins, minerals, and antioxidants, among other important macronutrients. This improved composition of a diet is likely to improve overall health of Americans and lower medical costs, but our paper does not attempt to quantify these indirect positive aspects.

6.2 Limitations and Directions for Future Research

There are four general unresolved issues pertaining to the design of such a campaign that should be the subject of more careful future research.

1) **Scope.** More research is needed to understand how big a program needs to be in order to be effective, and how can it be used to target specific demographic groups. For comparison purposes, the U.S. dairy industry spends about $450 million per year on fluid milk and dairy product advertising.

2) **Message Clarity.** Stakeholders in the fruit and vegetable industry need to be clear about their message. Fruits and vegetables, as a food category, are essentially competing with other “food groups” and growers might be better off thinking strategically as a food group
rather than as growers of several hundred individual commodities within a food group. It is possible to expand fruit and vegetable advertising through the use of commodity-specific advertising, but our results indicate that the more efficient and likely more successful way to increase demand for fruits and vegetables is through broad-based advertising.

3) **Funding.** That is, should such a campaign be financed by the government, industry stakeholders, or jointly between a public health agency and fruit and vegetable growers?

4) **Distributional Implications.** There will likely be distributional implications resulting from a broad-based campaign; that is, there will likely be winners and losers from broad-based advertising since the demand for some commodities may be more responsive to the advertisements than other commodities. This uncertainty would lead many growers to believe that broad-based advertising would be less effective for them than would commodity-specific advertising. Therefore, in order to get the fruit and vegetable industry to fully commit to a broad-based campaign, a government matching program (similar to current government programs that fund export promotion activities for certain U.S. agricultural products) may be needed to entice all industry stakeholders to contribute.
REFERENCES


Lusk, J. L., Hudson, D., 2004. Willingness-to-Pay Estimates and Their Relevance to


National Fruit and Vegetable Research and Promotion Board. 2009. Available at: [http://www.fvcampaign.org](http://www.fvcampaign.org)


Economic and Health Effects of Fruit and Vegetable Advertising: Evidence from Lab Experiments

TABLE 1. Means and Standard Deviations of Demographic Variables by Treatment

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Control</th>
<th>BB Ads</th>
<th>Apple Ads</th>
<th>BB &amp; Apple Ads</th>
<th>Potato Ads</th>
<th>BB &amp; Potato Ads</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>42.948</td>
<td>42.634</td>
<td>40.841</td>
<td>37.132</td>
<td>39.857</td>
<td>36.146</td>
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<td>Male</td>
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<td>0.195</td>
<td>0.341</td>
<td>0.395</td>
<td>0.238</td>
<td>0.354</td>
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<td></td>
<td>(0.428)</td>
<td>(0.397)</td>
<td>(0.475)</td>
<td>(0.490)</td>
<td>(0.427)</td>
<td>(0.479)</td>
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<td>Caucasian</td>
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<td>0.818</td>
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<td>0.714</td>
<td>0.729</td>
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<td>(0.441)</td>
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<td>(0.445)</td>
</tr>
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<td>African</td>
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<td>0.000</td>
<td>0.000</td>
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<td>0.083</td>
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<td>(0.000)</td>
<td>(0.000)</td>
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<td>(0.000)</td>
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<td>(1.132)</td>
<td>(1.153)</td>
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<td></td>
<td>(6.909)</td>
<td>(5.013)</td>
<td>(5.365)</td>
<td>(4.986)</td>
<td>(3.932)</td>
<td>(5.796)</td>
</tr>
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<td>Children</td>
<td>0.362</td>
<td>0.439</td>
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<td>0.211</td>
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<td>(0.497)</td>
<td>(0.488)</td>
<td>(0.408)</td>
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<td>(0.421)</td>
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<td>Primary Shopper</td>
<td>0.793</td>
<td>0.902</td>
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<td>0.854</td>
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<td>(0.353)</td>
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<td>Number of Fruit Servings</td>
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<td>2.238</td>
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<td>2.605</td>
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<td>(1.679)</td>
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<td>5 A Day</td>
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</tr>
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<td>(0.254)</td>
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<td>(0.149)</td>
<td>(0.307)</td>
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<td>(0.242)</td>
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<td>Quality of Apple Ads</td>
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<td>N.A.</td>
<td>3.705</td>
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<td>(1.240)</td>
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<td>Quality of Potato Ads</td>
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<td>N.A.</td>
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<td>N.A.</td>
<td>N.A.</td>
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<td>Quality of Broad Based Ads</td>
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<td>N.A.</td>
<td>(1.382)</td>
<td>N.A.</td>
<td>(1.119)</td>
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</tbody>
</table>
# subjects          | 58      | 41     | 44        | 38             | 42         | 48              |
# bids              | 464     | 328    | 352       | 304            | 336        | 384             |
<table>
<thead>
<tr>
<th>Treatment</th>
<th>Control</th>
<th>BB Ads</th>
<th>Apple Ads</th>
<th>BB &amp; Apple Ads</th>
<th>Potato Ads</th>
<th>BB &amp; Potato Ads</th>
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<tr>
<td>WTP: overall</td>
<td>0.741</td>
<td>0.836</td>
<td>0.692</td>
<td>0.832</td>
<td>0.740</td>
<td>0.814</td>
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<td>WTP: apples</td>
<td>0.624</td>
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<td>0.650</td>
<td>0.819</td>
<td>0.667</td>
<td>0.733</td>
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<td>(0.479)</td>
<td>(0.508)</td>
<td>(0.588)</td>
<td>(0.641)</td>
<td>(0.644)</td>
<td>(0.547)</td>
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<tr>
<td>WTP: bananas</td>
<td>0.466</td>
<td>0.476</td>
<td>0.373</td>
<td>0.591</td>
<td>0.400</td>
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<td>(0.472)</td>
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<td>0.646</td>
<td>0.552</td>
<td>0.963</td>
<td>0.629</td>
<td>0.650</td>
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<td>(0.431)</td>
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<td>1.117</td>
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<td>1.055</td>
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<td>(0.907)</td>
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<td>Mean ad likeness</td>
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<td>Implied price elasticities¹</td>
<td>Demographic Effects</td>
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<td>T2: Broad Based</td>
<td>0.034**</td>
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<td>T4: BB &amp; Apple</td>
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<td>0.015</td>
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<td>-0.574</td>
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<td>T5: Potato Ads</td>
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<td>0.019</td>
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<td>T6: BB &amp; Potato</td>
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<td>0.017</td>
<td>3.048</td>
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<td>-0.547</td>
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<td>0.003</td>
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<td>0.037</td>
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<td>Shopper</td>
<td>0.046</td>
<td>0.045</td>
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<td>Servings of Fruit</td>
<td>0.001</td>
<td>0.013</td>
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<td>Servings of Veg.</td>
<td>0.005</td>
<td>0.011</td>
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<td>Five-A-Day</td>
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<td>Conventional</td>
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<td>Constant</td>
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<td>0.251</td>
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Notes: # of Obs.: 2,062; *** p<0.01, ** p<0.05, * p<0.1; 
¹ Marginal effect is evaluated at the mean level of ad likeness; ² Implied elasticities are calculated at 3 points along the demand curve (at median, 25th and 75th percentiles of bid levels)
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<th>Food categories</th>
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<td>BB</td>
<td>BB+Apples</td>
<td>BB+Potatoes</td>
<td>Average</td>
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<td>Demand shocks (increase in WTP)</td>
<td>18.1%</td>
<td>32.8%</td>
<td>22.9%</td>
<td>24.6%</td>
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<td>Simulated Percentage Change in Quantities Consumed:</td>
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<td>Cereals and bakery</td>
<td>-2.07</td>
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<td>Red meats</td>
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<td>-6.69</td>
<td>-4.67</td>
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<td>Poultry and eggs</td>
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<td>4.35</td>
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<td>11.23</td>
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<td>Dairy</td>
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<td>Fruits and vegetables</td>
<td>11.48</td>
<td>20.80</td>
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<td>Nonalcoholic beverages</td>
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<td>Alcoholic beverages</td>
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<td>1.63</td>
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<td>Impacts on Per Capita Caloric Consumption and Weight:</td>
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<td>Annual consumption (kcal)</td>
<td>-1328.78</td>
<td>-2407.96</td>
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<td>Weight (lbs)</td>
<td>-0.84</td>
<td>-0.69</td>
<td>-0.48</td>
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<td>Weight (%)</td>
<td>-0.47</td>
<td>-0.85</td>
<td>-0.59</td>
<td>-0.64</td>
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</table>

*Note:* Average weight of an adult individual in 2005-2006 National Health and Nutrition Examination Survey was 178.5 lbs. The calculation assumes additional 3,500 kcal would add one pound to weight in steady state.
Economic and Health Effects of Fruit and Vegetable Advertising: Evidence from Lab Experiments

FIGURE 1. Overall Demand Changes with Broad-Based and Commodity-Specific Advertising

(i) Demand Changes with Broad-Based (BB) Advertising:

(ii) Demand Changes with Commodity-Specific Advertising Only: