AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

Comparison of Grocery Purchase Patterns of Diet Soda Buyers to Those of Regular Soda Buyers

by

James Binkley[1]

Purdue University, 403 W. State St, West Lafayette, IN USA 47907, jbinkley@purdue.edu

and

Alla Golub

Purdue University, 403 W. State St, West Lafayette, IN USA 47907, golub@purdue.edu

Selected paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Portland, Oregon, July 29-August 1, 2007

Copyright 2007 by James Binkley and Alla Golub. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.

[1] Corresponding Author: James Binkley,1-765-494-4261, fax 1-765-494-9176.

Abstract

The ultimate effect of regular and diet carbonated soft drinks on energy intakes depends on possible relations with other dietary components. With this motivation, this study compared grocery purchase patterns of regular and diet soft drink consumers using a large sample of US single person households. We tested for differences in food spending shares allocated to 43 food categories chosen mainly for their desirable/undesirable nutritional properties. We also investigated whether differences in purchased quantity of diet soft drinks are associated with differences in purchases of other food categories. We found a large number of significant differences, virtually all showing that more diet soda prone consumers make better nutrition choices, particularly regarding energy content. The study suggests that use of diet soft drinks does not lead to compensation by increased use of high energy foods.

Keywords: diet soda, food purchase pattern, homescan consumer panel data.

Introduction

Despite large improvements in the health and longevity of Americans over the past several decades, two disturbing trends have emerged. These are the rising prevalence of overweight and obesity in all age groups, and the associated rising incidence of type 2 diabetes (Schulze et al., 2004). These have paralleled important dietary changes, one of the most pronounced of which is a dramatic increase in consumption of carbonated soft drinks. According to Putnam and Allshouse (1999), between 1970 and 1997 the average per capita consumption of regular, or sugar sweetened, carbonated soft drinks nearly doubled, rising from 22.2 to 41.4 gallons per year, and consumption of diet soft drinks increased over five times, from 2.1 to 11.6 gallons. Analysis by Nielsen et al. (2002) found that during this period the percent of energy from soft drinks rose from 2.8 to 5.2. According to Block (2004), sugar sweetened soft drinks now account for over 7.1 % of calorie intake and comprise the largest single source of energy.

These trends have led to studies of the link between soft drink consumption and obesity. Studies have generally found a positive relation between high consumption of sugar sweetened soft drinks and obesity, in both adults and children (Mrdjenovic and Levitsky, 2003; Ludwig et al. 2001; Schulze et al., 2004). These imply that an increase in consumption of sugar sweetened soft drinks is not fully compensated by corresponding reductions in other sources of energy. This agrees with studies that have found compensation for calories in liquid form to be less than for solid form (Mattes, 1996). There is also evidence that the energy from the high fructose corn syrup used to sweeten soft drinks may have a greater effect on body weight than that from sucrose, due to different effects on appetite (Bray et al., 2004).

Because of such evidence, an appropriate policy might be to discourage soft drink consumption or to encourage the substitution of diet soft drinks for regular versions, perhaps through selective taxes. Unless individuals replace the foregone calories with energy from other sources, this strategy should lead to lower body weight overall. However, studies relating intake of artificially sweetened foods and body weight have yielded mixed results. Using various designs, several studies have found the relation to be negative (Ludwig et al. (2001); Raben et al. (2002); Tordoff and Alleva (1990); Della Valle, Roe and Rolls (2005)). Canty and Chan (1991), and Holt et al. (2000) found no measurable effect. At least two studies have found a positive effect. Appleton and Conner (2001) found a consistent positive relation between use of diet beverages and body weights; Stellman and Garfinckel (1986) found users of artificial sweetener more likely to gain weight than nonusers. Such results are counterintuitive, and may simply reflect selection problems: many people trying to lose weight are likely to choose diet drinks. Indicative of this is that Appleton and Conner (2001) found that consumers of diet drinks are also more concerned about their weight. However, there is a basis for a causal effect. Animal experiments have shown that artificial sweeteners can disrupt appetite control by breaking the conditioned association between sweet taste and intake of calories. The apparent response is to increase calorie consumption (Davidson and Swithers, 2004).

It is evident that uncovering the connection between soft drink consumption and obesity is difficult, particularly for diet drinks. The main problem is that it depends on the nature and extent of adjustments in consumption of other foods. For calorie-free soft drinks to ultimately lead to weight gain, consumers of these beverages would have to

increase calorie intake beyond what they would have if they did not consume diet drinks. Similarly, users of caloric soft drinks will gain weight unless they compensate by lowering consumption in other food categories. For example, some adjustment must have occurred to accommodate the increase in US per capita consumption of regular soft drinks noted above. Otherwise the extra calories just from soft drinks would have increased obesity more than has actually occurred.

In this paper, we use a new approach to the problem by employing a large set of retail food purchase data to examine the eating habits of consumers of regular and diet soft drinks. Our purpose is to investigate the extent to which purchases of other foods differ depending on the type of soft drinks chosen, and whether differences in the quantity of diet soft drinks purchased are associated with differences in purchases of other foods. We focus on foods that are thought to be nutritionally desirable, such as fruits and vegetables and low fat dairy products, and foods viewed as less nutritious and higher in calories. We also attempt to broadly estimate the calorie content of purchases of consumers grouped by their soda buying behavior.

Methods

Data

The data employed are from the ACNielsen Homescan Consumer Panel. ACNielsen collects this data by supplying participating households with home scanners with which they record all food products purchased from supermarkets, convenience stores, wholesale clubs, and drug stores. These are reported to ACNielsen on a weekly basis. Because the data are sold to major food firms who use it to assess the state of their

markets, stringent checks are imposed to maintain its integrity. ACNielsen began collecting this type of data in 1989, starting with 15000 households. By 1999, the year in which this study's data was collected, it had grown to 55000 households. The specific data used here is taken from a subsample selected because it includes not only scannable items, i.e. those with bar codes, but random weight purchases as well. These are important, for they include a large portion of fresh fruits and vegetables and a considerable part of fresh meat purchases. Special provisions are needed for panel members to record this data (Harris, 2005). The data used in this study represent records of grocery purchases of each household from January 1 to December 31 of 1999.

An obvious problem with the ACNielsen data is that it tallies the purchases by households, not individuals. When the household has more than one member, purchases represent the dietary choices of more than one person and dietary patterns cannot be attributed to a single person. For this reason we used only the subset of the data containing single person households. This left 1574 observations for the analysis.

Statistical Procedure

The basic question of interest to this study is the extent to which consumers who purchase larger quantities of diet soft drinks systematically tend to purchase larger or smaller quantities of other foods of nutritional significance. To adequately do this required dealing with a second data issue. The ACNielsen data does not include expenditures at restaurants. For some individuals this is a large portion of the budget, resulting in low grocery spending. Other people seldom dine out, and consequently have large grocery budgets. Thus, there are potentially large differences in total spending

across households. Large differences in total spending will cause large differences in spending on individual food categories, and this can be confounded with differences associated with soft drink choice. For example, consider two households, one with twice the spending of the other. The first is likely to have greater purchases of diet drinks and other food products than does the second, simply because of the higher spending. This can potentially bias estimates of the relationship between diet soda and other foods because the diet soda variable will not only measure soda consumption but will also proxy for total grocery spending.

To account for this we employed three procedures, all involving simple regression models. Each was estimated 43 times, for the 43 food groups described below. In all cases a measure of the household's purchases of a food was related to one or more factors measuring the extent to which a household purchases diet soft drinks. To account for the sampling design, the analysis was conducted with the SAS procedure Surveyreg, using ACNielsen-supplied sampling weights and 10 geographic strata (Harris, 2005).

The first equation is based on spending shares.[2] The dependent variable is the percent of grocery spending net of soda expenditures allocated to a particular food by the household. The single explanatory variable is diet soda's share of total household soft drink purchases, a measure of the extent to which households choose diet over regular soft drinks. If all households purchased only one type of soda, this would always be either zero or one, i.e. a dummy variable. As is well known, a regression with only dummy variables is equivalent to a comparison of sample means. The intercept would capture the estimated mean for those drinking only regular soda, and the dummy

[2] The first equation is estimated on the subsample of 1495 observations which excludes consumers buying no soda.

coefficient would estimate the difference in means for the two soda types. Using the share of diet drinks rather than a binary classifier allows for values between 0 and 1 and eliminates the need for arbitrary classification of each household as either only regular or diet soda drinker.

An advantage of examining shares is that it avoids the problem of differences in total spending across households. However, it has the weakness that no distinction is made between casual consumers of carbonated soft drinks and those who may drink several each day. The remaining equations address this. In both of these the dependent variable is the quantity, measured in ounces, of food *i* purchased by the household during the sample period. For the first equation the measure of diet drink purchasing behavior is simply the total ounces purchased by the household. The coefficient on this variable measures whether and to what extent the quantity of food *i* tends to increase or decrease as the household buys more diet soft drinks. Because this interpretation is subject to the confounding problem due to total spending differences noted above, total grocery spending was included as a second explanatory variable. Then the diet drink coefficient measures how purchased quantity of food *i* changes with changes in household purchases of diet drinks, spending held constant. In this way we can compare households with levels of total spending fixed but different amounts of diet soda.

In the last part of the analysis we used a regression equation to calculate and compare the mean quantities of various foods purchased by households categorized by their soda purchasing behavior. The groups used are (1) households buying only sugar sweetened soft drinks; (2) households who bought no soft drinks of either type; and (3-5) three groups consisting of diet soft drink buyers (many of whom also bought sugar

sweetened drinks) divided into thirds, based on the quantity of diet drinks purchased. The lowest tertile purchased less than 583 ounces, the middle tertile purchased between 583 and 3024 ounces, and the highest tertile purchased more than 3024 ounces of diet soda per year. Four dummy variables indicating group membership in groups 2 to 5 were created. These were used as the predictors in a regression with the quantity in ounces of each food as the dependent variable. Group 1 is the reference. As noted above, the coefficients in such a model are estimated differences in group means. Therefore, this equation is simply a convenient method for testing for mean differences between buyers of only regular soft drinks and the other four types of consumers.

To increase the comparability of the means across the groups, households with low grocery spending were not included in the estimation of the third equation.[3] This is important because we found large differences in average spending across the groups in the full sample. This is shown in Table 1. There is a very large difference between the high diet soft drink group and groups 1 and 2, both of which tend to spend much less. This is important because comparisons between these are the most useful for examining the effect of diet drink consumption. The difference is a consequence of our selection criteria. Selecting households on the basis of "high" or "low" total purchases of any good − diet soda in our case − will tend to select households with high or low total spending and, as a result, high or low purchases in other food categories.

Our choice of a cutoff for sample inclusion was that the household exceed the lowest quartile of annual spending, which is $832. This is a tradeoff between sample size, representativeness of the data used, and avoidance of large spending differences in

[3] For the purpose of comparison of means, total grocery spending is not included as an explanatory variable in this model. Otherwise the means would be means conditional on total spending, which complicates interpretation.

the groups. The average annual grocery spending of a household in each group in the reduced sample is also shown in Table 1. As can be seen, although differences remain they are considerably smaller.

The final issue is the choice of foods to be analyzed. The ACNielsen data is categorized into 621 "modules" or grocery categories from which the foods were selected. In the choice we considered foods' nutrition characteristics as well as their importance in terms of overall sales. Generally this involved disaggregating modules and combining portions of modules. This process resulted in 43 foods and food groups, accounting for about 80 percent of total spending in the data. They are listed in the first column of the results in Tables 2-4 below. Most are self descriptive. Several are pairs composed of regular and low fat versions of major grocery categories. In some cases the low fat versions were separate modules in the ACNielsen data; for others we disaggregated ACNielsen modules using a set of descriptor variables accompanying the data. The meat categories include fresh and frozen, and do not include meat with other ingredients (as in frozen meals). "Higher nutrition cereals" are composed of the upper quartile of cereals ranked by an index developed in another study using this data (Golub and Binkley, 2005). The categories are mutually exclusive. Thus, for example, "frozen french fries" is not included in "frozen and canned vegetables," and "cookies and crackers" are not included with "snacks." Viewed as a whole, these should be sufficient to describe the nature and extent of differences in diets of households classified by their soft drink purchases.

Results

Shares

The estimated intercept and slope of the share equation are listed in Table 2, in columns 2 and 3, respectively. In view of the previous discussion, the intercept is the estimated share for a regular-only buyer; the sum of the intercept and slope coefficient is the estimate for a buyer of only diet soda.[4] A positive slope coefficient implies a positive relation between consumption of diet soda and consumption of the food in question.

The results show that when measured by shares there is little or no evidence that choosing diet soda leads to compensation through increasing purchases of high calorie foods of other kinds. The reverse seems to be the case. In particular, those who chose calorie free soft drinks also tended to choose lower calorie versions of other types of food products. This is especially true of milk, ice cream, frozen dinners, and salad dressings, where they allocated significantly higher portions of food spending to low fat versions and lower portions to standard types. They also spent a significantly larger percent of their budget on fresh fruit and yogurt, and significantly less on foods higher in calories, like fruit juices and fruit drinks, frozen french fries, and sugar. The exceptions to this, such as cookies and crackers, and candy, are not statistically significant.

Quantities

The last column in Table 2 is the estimated slope when the quantity of each food is regressed on the quantity of diet drinks. For convenience, the estimate is multiplied by 100, so it measures how the ounces of the food in question changed given a 100 ounce

[4] It is important to point out the obvious fact that these shares are estimates. For example, if the household only buys diet drinks, then the spending share for sugar sweetened drinks is zero. However, the estimate of the percent of budget allocated to sugar sweetened soda is .76 (4.50-3.74).

increase in diet soda purchases, holding total spending constant.[5] There are some differences with the share equations. For example, as the quantity of diet drinks increased, dairy products of all kinds (including ice cream) tended to decline, rather than to switch from higher to lower fat types, as they did with rising diet soda share. The exception to this is the quantity of yogurt, which increased, although not significantly. The largest difference is that fresh and processed vegetables insignificantly increased with the share but significantly declined with the quantity. Also, snacks increased significantly as the quantity of diet soda increased, while if anything falling with the share. This is evidence that consumers of large quantities of diet soda are not completely focused on a nutritious diet.

Nevertheless, the predominant pattern is again an avoidance of higher calorie foods. The negative association of diet soda with fruit juice and fruit drinks is at least as strong as with shares. The same is true of salad dressings. In some cases, such as sweet baked goods and fats and oils, negative relations with high calorie items are stronger. Generally, most signs agree, although significance levels may not.

Group Means

Results for the group means regression are presented in Table 3. The intercept (column 2) is the estimated mean ounces for the reference group, those buying only regular soft drinks, and the remaining columns are the dummy variable coefficients. Indications of statistical significance refer to the difference between the group in question and the regular soda group. Thus, for example, those who bought no soft drinks (column 3) on

[5] Neither the intercept nor the coefficient on the total spending variable is of interest and neither is presented in Table 2.

average purchased 624.2 ounces more skim and 1% milk than did the regular soda group, for a total of 1425.1 (624.2+800.85). Retail purchases of diet soda by those with the highest purchases were indeed high: over 7500 ounces per year. They also bought regular soda − an average of 1086 ounces (3412-2326). Their total soft drink consumption was more than twice that of any other group. This, along with the fact they were the only group for whom diet soda predominated, makes them of primary interest here.

The results in Table 3 explain much of the apparent inconsistency between the share and quantity models in Table 2. For example, all three of the diet groups bought more low fat milk than did the sugar-sweetened group. But there was little difference among the three. This explains the lack of a significant effect for the quantity-on-quantity model in Table 2. A similar outcome is seen for frozen and canned vegetables, low fat ice cream, and low fat cookies and crackers. Viewing the results from all three methods suggests no systematic relation between fresh vegetable consumption and the amount and type of carbonated soft drinks purchased. One reason for this may be the diversity of the vegetable category.[6] Somewhat the same can be said of meat. This is especially true of beef and pork, the results for which depend very much on which method is used.

The remaining results in Table 3 suggest similar effects to those in Table 2, with the highest diet soda group having the strongest differences from the regular soda consumers. The most consistent outcome is that consumers of large quantities of diet soft

[6] Another reason is that fruits and vegetables are often sold not by weight but by the stalk, head, and so forth. For these the ACNielsen data simply assigns some standard weight, which may have little relation to the actual weight. Thus, the quantity data for fruits and vegetables may not be reliable.

drinks avoided high calorie drinks of all kinds. They were also more likely to buy low fat salad dressing and low fat ice cream instead of full fat types than are other consumers. Overall they showed a greater willingness to buy reduced calorie versions of standard foods, agreeing with the results of the share and quantity equations. The main departure from a pattern of calorie restriction was a greater tendency to purchase snack foods, cookies, and candy. These were all larger than the corresponding values for the buyers of regular soda only. The difference for snacks is particularly large for high diet soda group, although it is not highly statistically significant.

From the standpoint of nutrition the best strategy may be to avoid soft drinks of all kinds. Only a small number of the single person households in the sample did so in their grocery purchasing (Table 1). Results for this group (Table 3, column 3) show many similarities with the high diet soda group. The differences that do exist suggest that neither consumer type is consistently focused on nutrition. For example, while the non-soda users bought significantly less snacks and candy than regular soda buyers, they also bought less yogurt, while purchasing more regular ice cream (though the last two differences are not significant). However, buying patterns of both groups display greater nutrition concerns than do those of the other groups, especially that of the regular soft drink users.

Calories

The grocery buying patterns in Tables 2 and 3 suggest that consumers who choose diet soda over regular soda strive for and possibly achieve a lower calorie diet than do those who purchase only regular soft drinks. To be more definitive requires the calculation of

actual calorie intakes. While this is possible in principal, it is far beyond the resources of this study, for it requires data on the calorie content of many thousands of individual food items. We decided to adopt the simple alternative of estimating calories by using a single figure to represent the calorie content of all items in each of the 43 food categories.

The choices were based on selected food items taken from the USDA Nutrition Data Base (USDA Agricultural Research Service, 2006). This contains detailed nutrition information for thousands of foods and to our knowledge is the only publicly available source of such data. For our categories we selected between two and eight foods and took the average of their per-ounce calorie contents as provided in the USDA data. For more complex categories, like "frozen dinners & entrees", more foods were taken from USDA Nutrition Data Base, and for less complex categories, like milk, we choose less foods. We believe this method provides an approximation that is useful for comparing the buyer types and in showing the relative importance of the food types in determining energy intakes. However, we emphasize that it is an approximation.

The representative calorie contents for each food and the resulting calorie estimates (in calories per day) for the groups are shown in Table 4. Soft drinks were a major source of calories from grocery purchases only for the regular soda group and possibly the low diet soda group. But most of the larger calorie sources for all the groups were foods containing caloric sweeteners as a major ingredient, such as candy, bakery items, and ice cream. An important exception from this rule is snack foods, which were a major source of calories for all the groups. This is especially true for the high diet soda consumers, and as compared to the other groups, snack calories considerably offset their lower calories from sugar sweetened items.

Table 5 displays average total daily estimated calories and total actual ounces obtained by a member of each group from its purchases of the 43 foods.[7] These totals are further broken into their drink and non-drink components, where "drink" includes fruit juice, fruit drinks, and milk in addition to soft drinks. According to our estimates, the average total calories purchased by the high diet soda group were virtually identical to that of those buying regular soda only. On the face of it, this would seem to be evidence that substituting diet for regular soda does not result in a lower calorie diet. However, as seen previously (Table 1), even after eliminating the lowest quartile of total grocery spending from the sample, there remained a nearly two hundred dollar difference in spending between these two groups, with the high diet soda group spending more. (Although slightly more than half of this difference is due to the latter's higher total spending on soft drinks.) From comparison of daily ounces and calories of only regular soda with high diet soda groups, we see that high diet soda drinkers buy more ounces, but these ounces are less calorie dense.

A more valid comparison is within the three diet groups, because their spending is similar. Among these, the high diet group obtained the least calories from its total purchases, with the majority of the difference due to liquid dietary components (Table 5). This again shows that this group did not substitute caloric drinks of other types for caloric soft drinks. Most of the (smaller) difference in calories from non-liquid sources was due to less ounces consumed, for the implied calorie densities across the three diet groups are virtually the same. On this point, it is interesting to note that those who avoided soft drinks altogether had the fewest calories from non-liquid sources. In particular, even

[7] Each entry in the third column of Table 5, displaying average total daily calories for a household from each group, is a sum of the corresponding column in Table 4.

though they purchased the same non-liquid total ounces as did the high diet group, they obtained an estimated 120 less calories. Much of this can be attributed to differences in calories from snacks.

Discussion

Consumption of carbonated soft drinks, including both sugar sweetened and diet, has increased sharply since 1970, during a time when obesity and diabetes have become major health concerns. Several recent studies report that sugar sweetened soft drinks are associated with these problems. The role of diet soft drinks in these trends is less clear. Some have suggested that they also may have a detrimental effect, due to disruption of the sensory mechanisms associating sweetness with calories, or possibly simply because of consumer rationalization. For either kind of soft drink, the ultimate effect of an increase in consumption on health depends upon adjustments in other facets of the diet.

To assess such adjustments requires consideration of the dietary patterns of soft drink consumers. This cannot be done in the laboratory. It requires observational data, and to achieve any reasonable accuracy, large amounts of data are needed. Among the most complete food intake data available are the various versions of the USDA Continuing Survey of Food Intake by Individuals (CSFII), the last complete one of which occurred in 1994-96.[8] However, these are limited to at most three days of consumption as reported in interviews or in food diaries. Other data sets, while less detailed, involve longer time periods. The most prominent of these is the Nurses' Health Study, a prospective study of the health behavior and health outcomes of a very large sample of

[8] Actually the last occurred in 1998, but this was confined to preteen age children.

nurses, including information on self-reported food intake frequency. A version of this data was used in the Schulze et al. (2004) study cited earlier.

In this study, the issue of dietary habits of soft drinks consumers was addressed in an indirect manner through an examination of the grocery purchases patterns of a large sample of single person households. This very detailed and accurate data contains all grocery purchases for a representative sample of US households for a year, a sufficiently long period for the purpose of comparing purchasing patterns. We examined (1) the association between the percent of grocery spending allocated to various foods and the type of soft drink—regular or diet—typically chosen, as measured by the diet soda share of total household soft drink purchases; (2) changes in the quantity purchased of various foods as the quantity of diet soda increased; and (3) differences in average purchases of various foods by individuals classified into five groups according to the nature of their soft drink purchases. We also estimated calories associated with different soft drinks purchase patterns.

In the analysis of budget shares we found that households spending a larger share of their soft drink budget on diet soda had a general tendency to spend a larger share on nutritious foods and to avoid foods higher in calories and of less nutritional value. They avoided high calorie fruit juices and drinks and were more likely to choose lower fat versions of foods bought by most households, such as dairy products, frozen entrees, and salad dressings. Since reducing sugars and fat tends to entail a sacrifice in palatability, this suggests a greater willingness to sacrifice some sensory advantages for nutritional improvements.

Direct analysis of quantities and estimation of average purchases by the five groups found results similar to those with shares. Most inconsistencies were explained by the fact that in some cases differences between regular soda buyers and diet soda buyers did not depend upon how much diet soda was purchased. The most important exception was that individuals who purchased the most diet soda also purchased the largest amount of snack foods, far more than any of the other groups, including those buying smaller amounts of diet soda. This is important because by our estimates snack foods were a leading source of calories for all the soft-drink-buying groups. For the high diet group we estimate that they accounted for over ten percent of the calories from the foods we considered, and as compared to the buyers of regular soft drinks provided approximately 50 additional calories per day. In addition, we estimated the total daily calories of these two groups to be essentially the same. On the face of it these results suggests that people who replace regular soda with diet soda may compensate with increases in snack food calories, leading to no reduction in energy intake. But we believe this conclusion is not appropriate, because the high diet consumers had higher total spending, making it likely that grocery purchases comprised a larger part of their diet and thus calories. A more valid comparison is with the groups who also bought diet drinks but at much lower levels. These had similar levels of spending and obtained more total calories.

Nevertheless, it is reasonable to suppose that increased spending on diet soft drinks may induce more purchases of salty snacks, not because of calorie compensation but due to complementarity. Soft drinks of any kind are often eaten with snack foods, owing to the fact that increasing soft drink consumption enhances the desirability of such

foods. This is supported by the finding that the group who bought no soft drinks of either kind from grocery stores had by far the lowest snack purchases. It may be no coincidence that along with increasing per capita consumption of soft drinks has came an increase in calories obtained from snacks (Nielsen and Popkin, 2003). In any case, from results of this study it appears that snacks have the greatest potential for undermining a strategy of calorie control through consumption of artificially sweetened soft drinks.

The most important limitation of the study is the absence of information on food away from home. As stated previously this is the most likely source of differences in grocery spending across the sample, which makes comparisons difficult. Food away from home currently accounts for nearly fifty percent of total food spending. But because restaurant food is more expensive, the quantity share is smaller: Carlson et al. (1998) found that 72 percent of food quantity is eaten at home. In any case, we allowed for differences in total spending by explicitly including it as a variable in our quantity model and by eliminating low-spending households from our comparison of consumption means. We believe these measures ensure that the results reflect actual dietary behavior of the sample households.

A second possible problem with the lack of data on restaurant purchases is that a greater percent of soft drinks than most other foods are likely to be purchased and consumed outside the home. We examined the 1994-96 USDA Continuing Survey of Food Intake by Individuals and found that 60 percent of carbonated soft drinks were from retail food stores, suggesting that the ACNielsen data is unlikely to capture more than two-thirds of total soft drink consumption. Since our primary interest is differences

between consumer types, this incompleteness is a problem only if relative eating patterns at home differ markedly from those away from home. This does not seem likely.

It has been proposed that taxes should be imposed to discourage consumption of foods with high energy density. An interesting question is whether and how any such tax should be applied. Currently, several states already tax soft drinks by not including "junk" foods in a sales tax exemption for food sales (Jacobson and Brownell, 2000). But these apply equally to regular and diet drinks. From our study we feel confident in concluding that replacing sugar sweetened soft drinks with an equivalent amount of calorie free soft drinks will almost surely lead to *some* reduction in energy intake. Thus, if the goal is to encourage lower calorie diets, a more reasonable approach to soft drink taxation might be to exempt diet drinks from sales taxes while maintaining them on regular soft drinks, if not increasing them. Whether this would shift a significant amount of consumption from one to the other depends upon the degree of price substitution between them. Since they usually sell for the same price, this would be virtually impossible to estimate empirically. However, more than fifty percent of the households in this study bought both kinds, which suggests there may be considerable scope for a substitution effect.

In any case, it does not appear wise that both types of soft drinks undergo equal treatment in any policy imposed to achieve nutritional goals. A current example is provided by laws mandating the removal of soft drinks from schools. Although diet soft drinks may not be as good a choice as fruit juice (although from the standpoint of calories they obviously are), having them available while excluding the more popular sugar

sweetened versions could encourage children to develop the habit of choosing them in other situations.

Acknowledgments

The authors thank Professor of Food and Nutrition at Purdue University Richard Mattes and two unanimous reviewers for comments on earlier versions of the manuscript. This research was conducted under the Cooperative Agreement between USDA and Department of Agricultural Economics, Purdue University, “Purchase Patterns of Foods with Salient Nutrition Characteristics” (Purdue 596 1145-0699/0YT80).

References

Appleton, K.M., & Conner, M.T. (2001). Body weight, body-weight concerns and eating styles in habitual heavy users and non-users of artificially sweetened beverages. *Appetite, 37*, 225-230.

Block, G. (2004). Foods contributing to energy intake in the US: data from NHANES III and NHANES 1999-2000. *Journal of Food Composition Analysis, 17*, 439-447.

Bray, G. A, Nielsen, S.J., & Popkin, B.M. (2004). Consumption of high fructose corn syrup in beverages may play a role in the epidemic of obesity. *The American Journal of Clinical Nutrition, 79*, 537-543.

Carlson, A., Kinsey, J., & Nadav, C. (1998). Who eats what, when, and where? The Retail Food Center, Working Paper 98-05, University of Minnesota, November.

Davidson, T.L., & Swithers, S.E. (2004). A Pavlovian approach to the problem of obesity. *International Journal of Obesity, 28*, 933-935.

Della Valle, D. M., Roe, L. S., & Rolls, B. J. (2005). Does the consumption of caloric and non-caloric beverages with a meal affect energy intake? *Appetite, 44*, 187-193.

Canty, D. J., & Chan, M. M. (1991). Effects of consumption of caloric vs. noncaloric sweet drinks on indices of hunger and food consumption in normal adults. *American Journal of Clinical Nutrition, 53*, 1159-l164.

Golub, A., & Binkley, J. (2005). Household choice of breakfast cereals: healthy or unhealthy? Paper presented at the American Agricultural Economics Association Annual meeting, Providence, RI.

Harris, J.M. (2005). Using Nielsen homescan data and complex survey design techniques to analyze convenience food expenditures. Paper presented at the American Agricultural Economics Association Annual meeting, Providence, RI.

Holt, S. H. A., Sandoda, N., & Brand-Miller, J. C. (2000). The effects of sugar-free vs. sugar-rich beverages on feelings of fullness and subsequent food intake. *International Journal of Food Sciences and Nutrition, 51*, 59-71.

Jacobson, M. F., & Brownell, K. D. (2000). Small taxes on soft drinks and snack foods to promote health. *American Journal of Public Health, 90*, 854-857.

Ludwig, D. S., Peterson, K. E., & Gortmaker, S. L. (2001). Relation between consumption of sugar-sweetened drinks and childhood obesity: a prospective, observational analysis. *Lancet, 357*, 505-508.

Mattes, R.D. (1996). Dietary compensation by humans for supplemental energy provided as ethanol or carbohydrate in fluids. *Physiology & Behavior, 59*, 179-187.

Mrdjenovic, G., & Levitsky, D. A. (2003). Nutritional and energetic consequences of sweetened drink consumption in 6- to 13-year-old children. *The Journal of Pediatrics, 142*, 604-610.

Nielsen, S. J., Siega-Riz, A. M., & Popkin, B. M. (2002). Trends in energy intake in the U.S. between 1977 and 1996: similar shifts seen across age groups. *Obesity Research, 10*, 370-378.

Nielsen, S.J., & Popkin, B. M. (2003). Patterns and trends in food portion sizes: 1977-1998. *Journal of the American Medical Association*, 289, 450-453.

Putnam, J. J., & Allshouse, J. E. (1999). *Food consumption, prices, and expenditures*, 1970-97. Economic Research Service, U. S. Department of Agriculture, Statistical Bulletin No. 965.

Raben, A., Vasilaras, T. H., Moller, A. C., & Astrup, A. (2002). Sucrose compared with artificial sweeteners: different effects on ad libitum food intake and body weight after 10 wk of supplementation in overweight subjects. *The American Journal of Clinical Nutrition*, *76*, 721-729.

Schulze, M. B., Manson, J. E. Ludwig, D. S., Colditz, G. A., Stampfer, M. J., Willett, W.C., & Hu, F.B. (2004). Sugar-sweetened beverages, weight gain, and incidence of type 2 diabetes in young and middle-aged women. *Journal of the American Medical Association*, *292*, 927-934.

Stellman, S. D. & Garfinkel, L. (1986). Artificial sweetener use and one-year weight change among women. *Preventive Medicine*, *15*, 195-202.

Tordoff, M.G., & Alleva, A. M. (1990). Effect of drinking soda sweetened with aspartame or high-fructose corn syrup on food intake and body weight. *American Journal of Clinical Nutrition*, *51*, 963-969.

USDA, Agricultural Research Service (2006). Composition of foods raw, processed, prepared; USDA national nutrient data base for standard reference, release 19. Beltsville, Maryland, August.

Table 1 Grocery Spending by Consumers Classified by Soft Drink Purchases, for Full Sample and Those with Spending above the First Quartile

Soda buyer type	Full Sample		Annual Grocery Spending > $832	
	N	Average Annual Grocery Spending	N	Average Annual Grocery Spending
None	79	$1038	47	$1305
Regular Only	522	$1061	349	$1321
Low Diet, diet≤583 oz	324	$1255	261	$1509
Medium Diet, 583<diet≤3024 oz	324	$1234	261	$1486
High Diet, diet>3024 oz	325	$1417	261	$1513

Table 2 Results for Share Equation and Quantity-on-Quantity Equation

Food Group	Share Equation		Quantity Equation
	Intercept	Slope	Slope x 100
REGULAR SOFT DRINKS	4.50	-3.74***	-17.50***
DIET SOFT DRINKS	.36	5.51***	100.00***
MILK - WHOLE & 2%	2.76	-1.18**	-2.65
MILK - SKIM & 1%	1.56	1.12***	-0.03
BREAD – WHITE	2.62	0.22	-0.5
BREAD – DARK	1.02	0.00	0.23
FRESH VEGETABLES	2.66	0.44	-2.43***
VEGETABLES - CANNED & FROZEN	2.42	0.08	-1.10*
FROZEN FRENCH FRIES	0.34	-0.17***	-0.05
FRESH FRUIT	1.92	1.06***	0.46
FRUIT - CANNED & DRIED & FROZ	1.09	0.30*	0.85
FRUIT JUICE	3.48	-0.77**	-4.01***
FRUIT DRINKS	2.76	-1.18**	-4.64***
BEEF & PORK - FRESH & FROZEN	0.75	-0.05	-0.19
POULTRY - FRESH & FROZEN	2.62	-0.28	-0.15**
FISH - FRESH & FROZEN	1.85	0.23	-0.32*
BACON & SAUSAGE	2.28	-0.41	-0.23
REDUCED FAT BACON & SAUSAGE	0.21	0.1	0.18
EGGS	0.90	-0.21	-0.29***
NUTS	2.18	-0.07	0.25
FROZEN DINNERS & ENTRES	5.68	-1.07	-0.06
LOW FAT FROZEN DINNERS & ENTRES	1.18	1.53***	0.74**
CANNED SOUP	1.50	-0.09	-0.16
LOW FAT SOUP	0.24	0.19**	-0.07
LUNCH MEATS	1.21	-0.16	-0.15
LOW FAT LUNCH MEATS	0.28	0.17*	-0.02
CHEESE	3.05	-0.18	-0.31
LOW FAT CHEESE	0.46	0.49**	-0.09
YOGURT	0.68	0.88***	0.51
ICE CREAM	2.48	-0.61*	-1.49***
LOW FAT ICE CREAM	0.49	0.56***	-1.47
CEREAL	2.75	-0.18	0.01
CEREAL - HIGHER NUTRITION	0.97	0.30*	-0.16
COOKIES & CRACKERS	2.85	0.24	-0.35
LOW FAT COOKIES & CRACKERS	0.36	0.22***	0.06
SNACKS	4.58	-0.38	1.45***
LOW FAT SNACKS	0.29	0.17**	0.06
SWEET BAKED GOODS	3.75	-0.37	-0.88**
FATS & OILS	1.95	-0.19	-0.54***
SALAD DRESSINGS	0.98	-0.29**	-0.37***
LOW FAT SALAD DRESSINGS	0.20	0.41***	0.28***
SUGAR	0.51	-0.36***	-0.06***
CANDY	3.50	0.29	0.18

***, ** and * indicate significance at 1%, 5% and 10% levels, respectively.

Table 3 Mean Annual Ounces Purchased by Regular Soda Buyers and Differences from that Mean for Remaining Groups

Food Group	Regular Only	No Soft Drinks	Low Diet diet≤583 oz	Medium Diet 583<diet≤3024 oz	High Diet diet>3024 oz
REGULAR SOFT DRINKS	3412.01	-3412***	-296.3	-934.3	-2326***
DIET SOFT DRINKS	0.00	0.00***	197.48***	1252.7***	7725.6***
MILK - WHOLE & 2%	1422.33	-811.2***	-466.7**	-302.4	-570.0**
MILK - SKIM & 1%	800.85	624.20*	412.09	431.75**	403.82**
BREAD – WHITE	392.48	83.5	31.99	2.57	3.35
BREAD – DARK	201.27	33.66	-49.78	-47.51	2.21
FRESH VEGETABLES	858.48	96.74	-98.73	21.38	-105.4
VEGETABLES - CANNED & FROZEN	366.97	179.37	212.53**	232.07***	137.45**
FROZEN FRENCH FRIES	53.73	-2.59	13.87	6.21	-15.14
FRESH FRUIT	496.98	305.25	59.27	145.95**	134.7
FRUIT - CANNED & DRIED & FROZ	133.42	105.62	106.67**	170.78***	51.07
FRUIT JUICE	1272.94	187.2	-311.9**	-57.35	-622.3***
FRUIT DRINKS	722.88	-510.7***	356.23	56.63	-331.7***
BEEF & PORK - FRESH & FROZEN	217.55	-113.3***	10.44	29.75	18.96
POULTRY - FRESH & FROZEN	41.06	4.82	-7.65	17.89	2
FISH - FRESH & FROZEN	27.99	0.91	29.24	4.85	-6.2
BACON & SAUSAGE	163.00	9.51	-12.63	24.68	34.86
REDUCED FAT BACON & SAUSAGE	19.33	-3.18	3.09	0.06	18.23*
EGGS	104.69	2.75	16.98	21.7	-8.59
NUTS	111.40	-0.55	23.51	31.06	13.51
FROZEN DINNERS & ENTRES	471.22	-61.1	55.73	-0.41	-10.4
LOW FAT FROZEN DINNERS & ENTRES	90.53	97.41	10.9	22.67	131.80***
CANNED SOUP	213.72	-13.84	25.48	46.46	34.08
LOW FAT SOUP	46.68	-10.58	17.26	18.35	35.09
LUNCH MEATS	107.91	-36.02	-51.22**	-35.09	-4.76
LOW FAT LUNCH MEATS	14.57	7.09	-5.45	5.48	9.53
CHEESE	191.45	-73.31**	-8.83	48.47	-3.87
LOW FAT CHEESE	39.78	-7.22	36	17.14	55.58
YOGURT	148.86	-23.63	40.26	61.62	140.75**
ICE CREAM	440.23	180.89	26.08	-118.3*	-142.6**
LOW FAT ICE CREAM	55.58	169.09**	316.45	119.11***	100.49***
CEREAL	190.18	22.31	-17.37	13.82	24.36
CEREAL - HIGHER NUTRITION	92.99	76.72	-2.52	40.69*	-6.83
COOKIES & CRACKERS	211.87	47.09	88.63*	44.48*	51.81
LOW FAT COOKIES & CRACKERS	21.29	13.88	29.38**	15.16***	20.39***
SNACKS	313.32	-115.5*	24.6	3.9	122.58*
LOW FAT SNACKS	18.72	-7.52	10.94	3.79	10.8
SWEET BAKED GOODS	373.27	32.02	61.62	45.3	-51.55
FATS & OILS	79.70	11.0	31.02*	58.36	-17.22
SALAD DRESSINGS	120.14	-83.89***	-19.99	-7.36	-34.52**
LOW FAT SALAD DRESSINGS	22.94	22.02	10.45	24.34***	47.37***
SUGAR	11.83	0.76	-0.56	1.25	-6.30***
CANDY	239.68	-114.1***	62.20*	23.13	56.63*

***, ** and * indicate significance at 1%, 5% and 10% levels, respectively.

Table 4 Average Estimated Calories per Day from 43 Foods by Five Household Groups

Food Group	Estimated Calories/oz	Regular Only	No Soft Drinks	Low Diet diet≤583 oz	Medium Diet 583<diet≤ 3024 oz	High Diet diet>3024 oz
REGULAR SOFT DRINKS	11	102.83	0.00	93.90	74.67	32.73
DIET SOFT DRINKS	0	0.00	0.00	0.00	0.00	0.00
MILK - WHOLE & 2%	17	66.25	28.46	44.51	52.16	39.70
MILK - SKIM & 1%	11	24.14	42.95	36.55	37.15	36.31
BREAD – WHITE	70	75.27	91.28	81.41	75.76	75.91
BREAD – DARK	70	38.60	45.05	29.05	29.49	39.02
FRESH VEGETABLES	15	35.28	39.26	31.22	36.16	30.95
VEGETABLES - CANNED & FROZEN	20	20.11	29.94	31.75	32.82	27.64
FROZEN FRENCH FRIES	60	8.83	8.41	11.11	9.85	6.34
FRESH FRUIT	15	20.42	32.97	22.86	26.42	25.96
FRUIT - CANNED & DRIED & FROZ	18	6.58	11.79	11.84	15.00	9.10
FRUIT JUICE	13	45.34	52.00	34.23	43.30	23.18
FRUIT DRINKS	14	27.73	8.14	41.39	29.90	15.01
BEEF & PORK - FRESH & FROZEN	65	38.748	18.56	40.60	44.04	42.12
POULTRY - FRESH & FROZEN	60	6.76	7.54	5.49	9.69	7.08
FISH - FRESH & FROZEN	55	4.22	4.36	8.62	4.95	3.28
BACON & SAUSAGE	130	58.05	61.44	53.55	66.84	70.47
REDUCED FAT BACON & SAUSAGE	70	3.71	3.10	4.30	3.72	7.20
EGGS	50	14.34	14.72	16.67	17.31	13.16
NUTS	185	56.46	56.19	68.38	72.21	63.31
FROZEN DINNERS & ENTRES	35	45.19	39.33	50.53	45.15	44.19
LOW FAT FROZEN DINNERS & ENTRES	28	6.94	14.42	7.78	8.68	17.06
CANNED SOUP	17	9.95	9.31	11.14	12.12	11.54
LOW FAT SOUP	14	1.79	1.38	2.45	2.49	3.14
LUNCH MEATS	60	17.74	11.82	9.32	11.97	16.96
LOW FAT LUNCH MEATS	35	1.40	2.08	0.87	1.92	2.31
CHEESE	100	52.45	32.37	50.03	65.73	51.39
LOW FAT CHEESE	55	5.99	4.91	11.42	8.58	14.37
YOGURT	23	9.38	7.89	11.92	13.26	18.25
ICE CREAM	70	84.43	119.12	89.43	61.73	57.08
LOW FAT ICE CREAM	50	7.61	30.78	50.96	23.93	21.38
CEREAL	105	54.71	61.13	49.71	58.68	61.72
CEREAL - HIGHER NUTRITION	95	24.20	44.17	23.55	34.79	22.42
COOKIES & CRACKERS	107	62.11	75.91	88.09	75.15	77.30
LOW FAT COOKIES & CRACKERS	97	5.66	9.35	13.46	9.69	11.08
SNACKS	145	124.47	78.61	134.24	126.02	173.16
LOW FAT SNACKS	115	5.90	3.53	9.34	7.09	9.30
SWEET BAKED GOODS	105	107.38	116.59	125.11	120.41	92.55
FATS & OILS	200	43.67	49.70	60.67	75.65	34.24
SALAD DRESSINGS	170	55.96	16.89	46.65	52.53	39.88
LOW FAT SALAD DRESSINGS	50	3.14	6.16	4.57	6.48	9.63
SUGAR	130	4.21	4.48	4.01	4.66	1.97
CANDY	155	101.78	53.32	128.20	111.61	125.83

***, ** and * indicate significance at 1%, 5% and 10% levels, respectively.

Table 5 Daily Ounces Purchased and Estimated Calorie Content, by Soda Buyer Type

Soda Buyer Type	All Purchases		Drinks		Non-Drinks	
	Ounces	calories	ounces	calories	ounces	calories
Only Regular	39.3	1490	20.9	266	18.4	1223
No Soft Drinks	30.8	1349	10.2	132	20.7	1218
Low Diet, diet≤583 oz	41.9	1651	20.6	251	21.3	1400
Medium Diet, 583<diet≤3024 oz	43.6	1620	22.1	237	21.4`	1383
High Diet, diet>3024 oz	53.3	1485	32.6	147	20.7	1338