Using Extremeness Aversion to Fight Obesity: Policy Implications of Context Dependent Demand

KATHRYN M. SHARPE
RICHARD STAELIN
JOEL HUBER*

This article illustrates how the compromise effect alters consumers' selection of soft drinks. Using three within-subject studies, we show that extremeness aversion and price insensitivity cause consumers to increase their consumption when the smallest drink size is dropped or when a larger drink size is added to a set. As a result rational firms find it best to drop the smaller sizes and add a larger size, thus increasing overall consumption. After estimating each individual's demand as a function of price and drink size availability, policy experiments demonstrate how it is possible to reduce soft drink consumption without additional taxation.

This article uses a well-known behavioral theory, the compromise effect (Simonson 1989; Simonson and Tversky 1992), to help understand and address the problem of obesity. Obesity is a major concern since the estimated health care cost in the United States associated with overweight citizens is well over $100 billion (DHHS 2001; Finkelstein, Fiebelkorn, and Wang 2003). Nearly half of this expense is borne by government health care programs (Medicaid and Medicare), while much of the remainder is met by health insurance premiums (Finkelstein et al. 2003). Because these costs are spread over all taxpayers and insurance premium holders, obesity imposes negative externalities on much of society.

We center our attention on soft drink consumption within the context of the fast food industry, although the effect of offered sets on resulting portion sizes applies quite generally. We acknowledge that this sphere of attention addresses only a portion of the obesity problem. However, we note that the major reason for the rise in obesity within the United States is the 18% increase in consumption over the last 4 decades and not necessarily a decrease in exercise or activity levels (CDC 2001, 2006a; Cutler, Glaeser, and Shapiro 2003; Kruger, Ham, and Kohl 2005). This increase in consumption has been mirrored by increased portion sizes (Schwartz and Byrd-Bredbenner 2006), particularly for food consumed at restaurants and fast food establishments (Shapiro 1993; Young and Nestle 2002). Interestingly, the greatest proportional increase in fast food portion sizes has not come from hamburgers (an 18% increase) or cheeseburgers (24%) but from french fries (57%) and sweetened beverages (62%; Nielsen and Popkin 2003). Sweetened soft drinks, which represent 69% of all soft drinks sold (Freedonia Group 2007), provide approximately 11 calories for every fluid ounce consumed. For example, if a person switches from a 21-ounce drink to the next largest 32-ounce drink, this action increases the caloric intake of the consumer by 121 calories. If this increase in consumption was to occur daily, the individual would gain approximately 8 pounds within a year, all else equal. Consequently, altering an individual's purchase habits to purchase a smaller-sized drink could help to reverse the trend of increased caloric consumption.

Our basic premise is that consumer purchases are altered

*Kathryn M. Sharpe is a doctoral candidate, Duke University, Durham, NC 27701-0120 (kathryn.sharpe@duke.edu). Richard Staelin is the Edward and Rose Donnell Professor of Business Administration, Duke University (rstaelin@duke.edu). Joel Huber is the Alan D. Schwartz Professor of Marketing, Duke University (joel.huber@duke.edu). Correspondence: Kathryn M. Sharpe. The authors would like to especially thank Kelly Davis and Greg Allenby for their research contributions, Jim Wulforst and Rafael Perez for their assistance in dining services, as well as Bob Clemen, Preyas Desai, Michael Lavine, and John Lynch for their helpful suggestions and comments on previous drafts of this article. They also acknowledge the many useful comments from the participants at presentations at the 2005 Kenan Obesity Reduction Partnership Conference at the University of Chapel Hill, the Fuqua School of Business 2006 Summer Workshop, the 2006 Winter AMA educator's conference, the 2006 ACR conference, the 2006 Marketing Science conference, and the 2007 SICS conference. Finally, they acknowledge the editor, associate editor, and three reviewers who suggested additional analyses and in general provided guidance throughout the review process.

John Deighton served as editor and Brian Ratchford served as associate editor for this article.

Electronically published April 16, 2008

 0093-5301/2008/3503-0011$10.00. DOI: 10.1086/587631

by the portfolio of drink sizes made available. Using a series of experiments involving actual and "simulated" purchase and consumption behavior, we provide evidence that this malleability of behavior has led profit-maximizing fast food outlets to gradually drop smaller sizes from their portfolio of available drinks and add larger drink sizes, ultimately leading to an increase in caloric consumption. We also use these experiments to estimate individual consumers' aversion for the smallest and largest portion sizes, along with their inherent utility for each drink size and their disutility for price. We then use these estimates in policy simulations to illustrate how one could evaluate a number of approaches aimed at reducing consumption of soft drinks.

In addition to showing how the compromise effect can be used to address a major public policy problem, our research augments prior research on this effect in two ways. First, we use a within-subject design instead of a between-subject design used in prior studies to measure the effects of extremeness aversion. As demonstrated by Hutchinson, Kamakura, and Lynch (2000), within-subject data enable us to avoid aggregation bias and thereby reveal a more nuanced view of switching behavior by quantifying the magnitude of any systematic changes in the individual's purchase behavior arising from extremeness aversion. Second, our research supplements the health literature by providing another explanation for why drink portion sizes might have increased over the last few decades.

RELEVANT LITERATURE

The underlying premises linking this research to the obesity problem depend on four well-supported behavioral findings. First, consumers have little knowledge of their actual caloric consumption (Chandon and Wansink 2007a, 2007b; Yehling and Marcouiller 2005). For example, when Burton et al. (2006) asked consumers to estimate the number of calories in different fast food meals, they found most people believed that these meals contained 700–800 calories, about half of the actual amount associated with the meal.

Second, providing consumers with correct information about caloric content has limited impact on their behavior. We acknowledge that some people have suggested that the above-noted lack of caloric knowledge can be addressed by better availability of nutritional information within restaurants (Burton et al. 2006). However, there is little empirical evidence to support such a contention (Moorman 1996). For example, in a large field study that displayed nutritional and caloric information, Russo et al. (1986) found minimal changes in grocery-shopping behavior. Although not the primary goal of our research, we also find that providing such information does not significantly alter the quantity purchased. Taken together these findings attest to the difficulty of using cognitive and motivational information strategies against obesity.

Our third premise states that consumers tend to eat what is put in front of them. There are numerous research studies showing that children and adults eat more when given larger portion sizes (Fisher, Rolls, and Birch 2001, 2003; Kral et al. 2002; Kral, Roe, and Rolls 2004; Levitsky and Youn 2004; Nisbett 1968; Rolls, Engell, and Birch 2000; Rolls, Morris, and Roe 2002; Sobal and Wansink 2007; Wansink 2004, 2006; Wansink, Painter, and North 2005). For example, Wansink (1996) demonstrates that consumers given larger containers tend to use a larger amount of the item, and Geier, Rozin, and Doros (2006) observe that people consume substantially more M&Ms when they self-serve themselves using a larger spoon compared to a smaller spoon. We augment these results by showing that our consumers consumed the vast majority of what they purchased. Thus, increased purchase behavior ultimately leads to increased consumption.

Our final premise is that consumer choice is often modified by specific environmental factors related to the situation. Bettman, Luce, and Payne (1998) demonstrate through a vast review of the literature that consumers often construct various heuristics and strategies to help them make choices and that these heuristics are highly contextual and dependent on the situation at hand. They describe how factors such as time pressure, number of options, missing information, information format, and the options in the choice set affect the particular heuristic used and thus the choice made. Our main interest is in this latter factor, that is, that consumers tend to avoid the extreme options. We soon present evidence that this tendency has substantial implications for the purchase of soft drinks in a fast food environment.

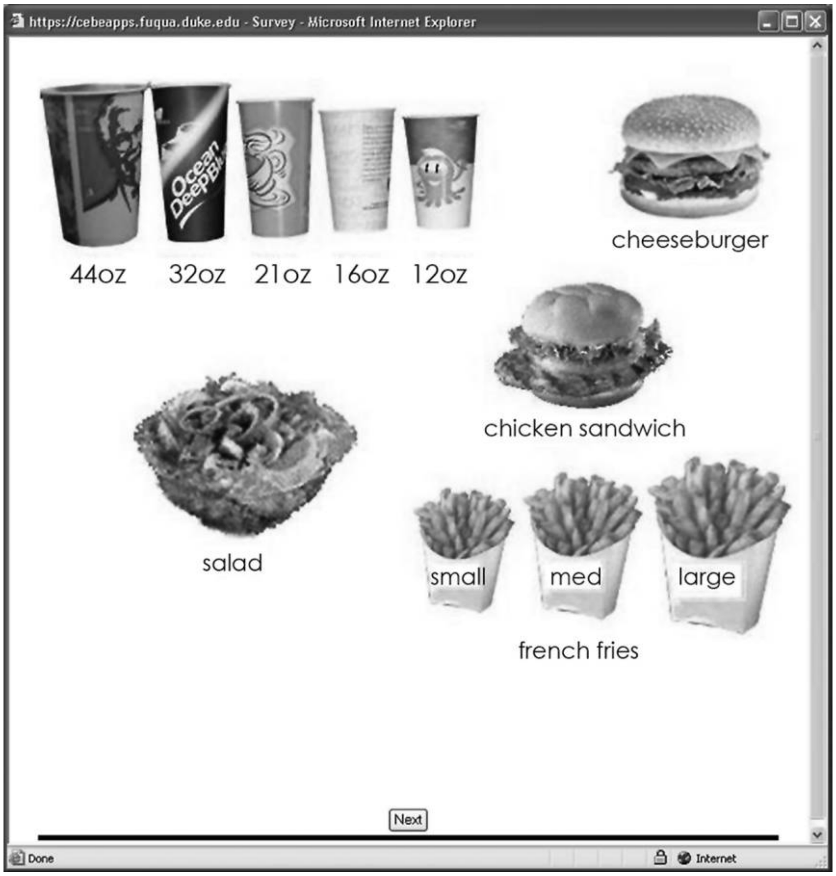
METHODOLOGY

Overview

In order to evaluate any policy and its effects on soft drink purchase behavior, we need to characterize the demand for soft drinks. Consequently, we develop a procedure for estimating for a given individual, the effects of (*a*) a drink size being the smallest or largest drink available, (*b*) the price of the drinks, and (*c*) a person's innate preference for a particular-sized drink on the person's purchase and consumption behavior. We do this by asking participants to imagine that they are going on a road trip where they will be stopping at a number of fast food restaurants. At each restaurant they have the option of selecting an entrée, a side order, and a drink. We manipulate the menus so that different restaurants carry different portfolios of drink sizes. For example, a 16-ounce drink is sometimes the smallest drink available, and other times it is an intermediate level. In a pretest (referred to subsequently as the McDonald's validation study), we assess the validity of this approach by asking a sample of young adults to complete our virtual road trip task and then about a week later to purchase and consume a fast food meal from a local McDonald's restaurant. The menu used to purchase the McDonald's meal was identical to one of the menus participants previously saw during their simulated road trip. We compare their simulated and actual purchase behavior to determine their consistency (reliability) across the two experiences. In addition we use the

FIGURE 1

STIMULI FROM ROAD TRIP PORTION OF THE EXPERIMENTS: TYPES OF ITEMS TO BE OFFERED DURING THE ROAD TRIP



NOTE.—Color version available as an online enhancement.

consumption information to determine the correspondence between purchase behavior and actual consumption.

After determining that our procedure is internally consistent, yields externally valid results, and is predictive of actual consumption, we use the same general approach on a national sample of adults who have indicated that they eat meals at fast food restaurants. We use this sample to determine whether adult consumers systematically alter their choice of drink sizes depending on the portfolio of available drink sizes. For example, consider two sets of drink portfolios, the first composed of a 12-, 16-, 21-, 32-, and a 44-ounce drink size and the second lacking the 12-ounce drink size. If consumers are averse to buying the smallest size, we expect a subset of participants who bought a 16-ounce drink, when the 12-ounce drink was available, to purchase the 21-ounce drink, when the 12-ounce drink is dropped, since the 16-ounce drink becomes the smallest-sized drink available. We also use this national sample to estimate a utility model of consumer choice to assess the degree to which consumers show extremeness aversion.

Finally, we sample a focal restaurant's local market using the same methodology as in the national sample study. We estimate the same individual level model as used in the national sample study and use these estimates to run a series of policy simulations to illustrate how one could assess the impact of specific policy actions on soft drink caloric consumption.

McDonald's Validation Study—Link between Road Trip and Actual Choice

In the validation study, 152 Duke University students completed a two-part study in which the first part involved an online simulated road trip and the second part tracked actual purchasing and consumption of a lunch meal from McDonald's. The first part is almost identical to the tasks performed in the two other studies and is described in detail below.

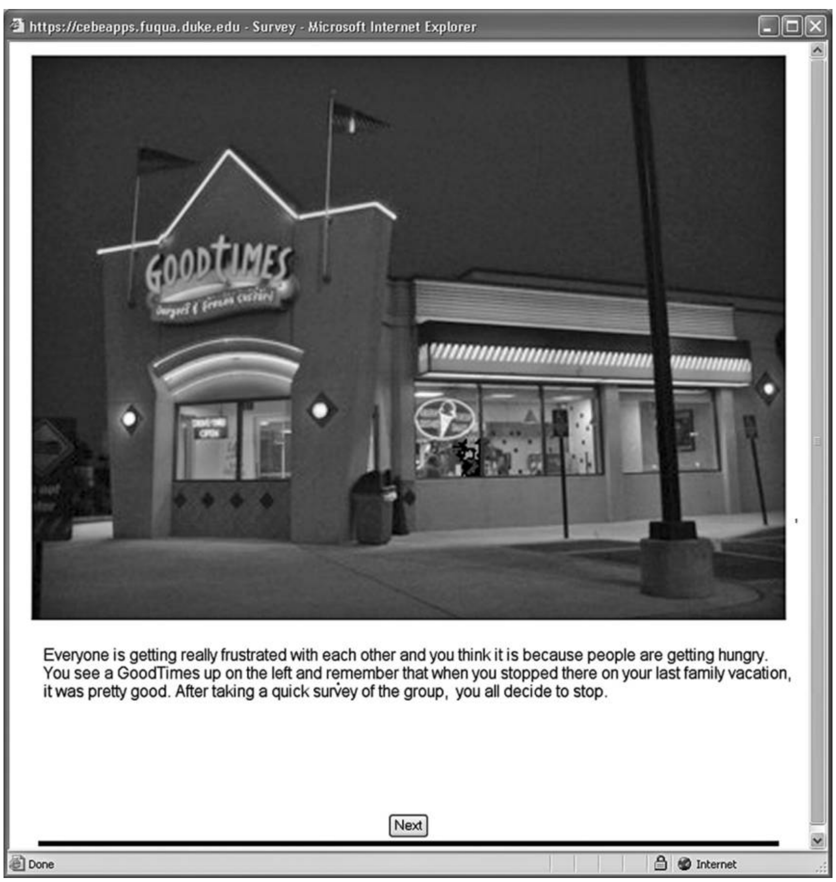
Before starting the simulated road trip, participants viewed pictures similar to those shown in figure 1 giving the potential drink sizes (12, 16, 21, 32, and 44 ounces), side order sizes, and many of the entrées available at the restaurants visited during the road trip. To make the experience more realistic, add interest to the task, and reduce the need for variety seeking (Menon and Kahn 1995), participants read scenarios characterizing each visit during the road trip. These scenarios provided information about the restaurant and the reason for its selection. Also, to limit prior experience with a restaurant in determining soft drink size, none of the restaurants in the study were associated with a major fast food chain, but they were still real establishments (see fig. 2 for an example). After reading the scenario and seeing a picture of the restaurant, participants were asked to choose an entrée, a side order, and a drink from a menu similar to the one shown in figure 3. After making their meal choices, they were provided with the total meal price.

Participants made nine such stops during the road trip, with the type of restaurant and the food choices changing at each stop. Both the assignment of assortment conditions and the order of the nine restaurants varied across participants. Each restaurant had a particular "type" or theme in terms of the entrées. These included beef (hamburgers), chicken, pasta, pizza, fish, and Mexican. Likewise each restaurant carried both diet and nondiet drinks associated with a specific parent brand of drinks (Coke brand vs. Pepsi brand). (In a prior pretest we found no systematic effect of restaurant name or type, order of the trip, or parent brand of drinks on purchase behavior; thus, we do not discuss these experience attributes again.) Prices were held fixed for each of the soft drink and french fry sizes to match the prices posted at the local McDonald's. Participants were not forced to choose an entrée, a side order, or a drink, thereby reducing demand effect (Dhar and Simonson 2003; Nowlis, Kahn, and Dhar 2002). However, empirically all of the participants purchased at least one item on every stop on their virtual trip.

The focal manipulation in this and the following studies was the portfolio of drink sizes available. In this validation study participants saw three different drink menus. The first contained 16-, 21-, and 32-ounce drinks. We refer to this condition as the core condition since all of the menus used in this study contain these three drink sizes. The second drink menu condition, the high condition, augments these three drink sizes with a 44-ounce drink, while the low con-

FIGURE 2

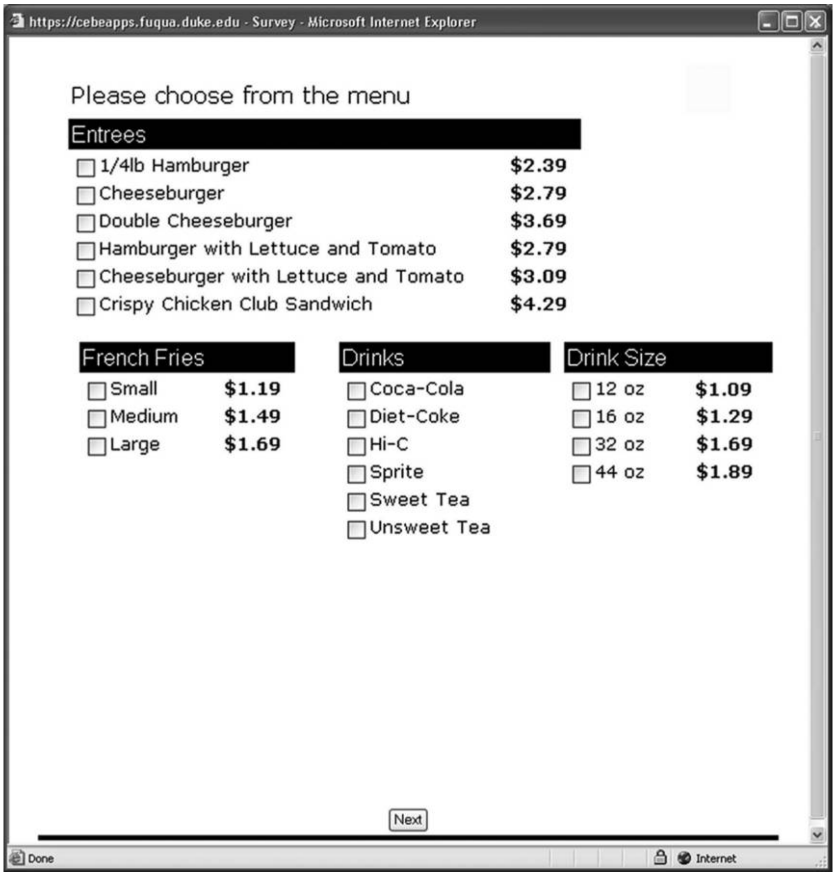
STIMULI FROM ROAD TRIP PORTION OF THE EXPERIMENTS: EXAMPLE OF A RESTAURANT AND TRIP SCENARIO



NOTE.—Color version available as an online enhancement.

FIGURE 3

STIMULI FROM ROAD TRIP PORTION OF THE EXPERIMENTS: EXAMPLE MENU



NOTE.—Color version available as an online enhancement.

dition drops the 44-ounce but adds a 12-ounce drink. Since participants made nine trips, they saw each menu type three times. We use this design feature to determine how reliable (internally consistent) participants were in terms of buying the same size drink each time, conditional on the portfolio of available drinks. This allowed us to establish a benchmark when assessing the correspondence between the person's road trip and actual purchase behavior.

The validation stage of the study took place about a week after the participants completed the online-shopping task. Participants came to a room in the student union at lunch time with the understanding that they would be filling out a brief survey in addition to eating lunch purchased from McDonald's. Before coming they were told that they might have some spare time and thus that they should bring along some study material (finals were scheduled for the next week). Upon arrival, participants were told that they would be paid at the end of the study $10.00 for completing the study as well as an additional $7.50 (or $6.00) to purchase their lunch, which they were to eat while they read or studied. They ordered food from one of three menus especially designed for the study. These menus were identical to one of the nine menus used in the virtual shopping trip and included six of the most popular entrées sold at the local McDonald's. It also included three sizes of fries and one of the three drink size conditions, in which the drink condition used was randomly determined for each individual. Participants were then asked to go into a quiet room, reserved for the experiment, where they could study and ultimately fill out a brief survey. Soon after they entered this room, their meal was delivered to them. Twenty-five minutes later they completed the survey about their study habits and an open-ended question assessing their beliefs about the purpose of the study. After completing this survey they were excused and told to leave the remaining contents of their meal at the table where they were sitting. Each person's meal remnants were later collected and weighed to determine the percent of the meal the person consumed.

McDonald's Validation Study Results

Before discussing our results, we note that initially we allocated participants $6.00 to pay for their meal. However, the prices of some of the entrées in combination with a side order of fries meant that buying any drink required the person to exceed the \$6.00 limit. It appears that many of the participants treated this \$6.00 amount (instead of the \$16.00 total compensation associated with the combined study) as a constraint on how much they could order. As a consequence we observed a larger proportion of participants not ordering a drink than was predicted from their virtual road trip behavior (where there was no explicit budget constraint). In order to make the two experiences more comparable, we altered our procedures for the last 66% of participants (i.e., 102 participants) by increasing the amount given for purchasing the meal to \$7.50. In the following analyses we always control for this "manipulation."

We conduct three analyses to determine the correspondence between actual and simulated purchase behavior. First, we compare the aggregate market shares as determined from the actual and simulated purchase occasions for those who purchased a drink. As shown in table 1 there is a very strong correspondence between the two sets of market shares, indicating that the total purchase quantity did not vary significantly from the virtual to the actual experience.

Second, we compare the internal reliability of the virtual purchases with the actual consumption purchases. We do this by comparing the chosen drink size on each occasion. To estimate the reliability of the virtual purchases, we compare (*a*) the first choice made in a given format with the second choice made in that same format and (*b*) the second choice with the third choice, again holding the format fixed. Since there were three drink conditions in the virtual road trip for each of these two comparisons, we have six measures of the person's consistency within the virtual road trip. These measures tell us how reliable the participants were in making choices within the road trip. To determine how reliable the participants were a week later in an actual consumption experience, we compare each individual's third simulated experience with their actual consumption choice, again holding fixed the menu format. We use this last measure to determine whether the consumers' consistency changes because of the long time lapse—and thus is a different context (e.g., time since last meal, different mood, etc.)—or because the task is somewhat different (i.e., computer-simulated road trip vs. actual food ordering) or both.

We regress these seven measures per participant against (*a*) the drink condition, (*b*) the comparison (i.e., the first, the second, or the third), and (*c*) a dummy to indicate whether the purchase occasion was associated with the budget constraint. The coefficients for the three drink conditions (core = .69, $p < .001$; low = .78, $p < .001$; high = .70, $p < .001$) are our best estimates of the initial consistency for that format; the coefficient for the difference between the second and third choice (.06, $p < .01$) indicates that consumers become 6% more reliable on the third choice, while the coefficient for the difference between the third road trip choice and the actual consumption McDonald's choice ($-.099$, $p < .05$) indicates an estimated 9.9% decrease in reliability attributed to the actual purchase versus the last virtual purchase, and this reliability decreased by another 9.7% if the participants were in the \$6.00 budget condition, although this difference is not statistically significant ($p = .192$). When we tested to see whether this decrease in consistency varied by drink size, we found no significant effect. We take these results as evidence that although there is some decrease in reliability after a week, the person's simulated purchase behavior is highly predictive of this person's actual purchase behavior.

TABLE 1

MARKET SHARE AT MCDONALD'S VERSUS VIRTUAL ROAD TRIP (%)

	Size				
Condition	12 oz.	16 oz.	21 oz.	32 oz.	42 oz.
Core		61 (61)	31 (29)	8 (9)	
Low	44 (42)	30 (31)	18 (19)	8 (8)	
High		61 (58)	32 (30)	5 (9)	3 (3)

NOTE.—Market share from the virtual road trip is in parentheses.

Finally, since we are ultimately interested in caloric consumption, we analyze the correspondence between what the person actually purchased and what the person actually consumed. We do this separately for entrées, side orders, and drinks. Specifically we regress the calories consumed against the calories purchased for each item, controlling for the drink condition. We find no effect of drink condition on calories consumed for entrées and side orders. However, we find a highly significant impact of the amount purchased on the amount consumed. Specifically, we estimate that participants consume 93% ($p < .0001$) of their entrée and 93% ($p < .0001$) of their side order. For soft drinks we find the percent consumed is 83% ($p < .0001$) overall and is not a function of the drink condition, drink size, or whether the person bought a diet or nondiet drink.

In summary we find strong evidence that the virtual road trip survey yields remarkably valid results. Not only do we find no tendency for people to purchase more or less (in terms of quantity) during the simulated purchasing experiences; we also find that the person's selections of a particular drink size in the virtual shopping task strongly correspond to the person's actual drink size choice. Finally, this choice maps into the person's consumption of the food purchased. These findings validate the use of our virtual road trip methodology to estimate purchase and consumption behavior of a broader set of participants without having to observe their actual purchase behavior. This conclusion is important since it justifies the use of the road trip task to (*a*) examine the impact of the different drink formats on participants' purchase behavior, (*b*) estimate utility functions for two different samples of participants, and (*c*) make general assertions concerning how different policies should affect consumers' consumption patterns.

National Sample Study

Participants for this study were 304 adults over age 20 who frequented fast food restaurants at least once a month.

These participants were compensated by an independent market research firm that maintains a panel of participants who periodically participate in different research studies. The participants live throughout the United States and closely approximate the U.S. demographics on gender, ethnicity, and race.

The study used a simulated trip similar to that used in the McDonald's validation study with a few minor changes. As before, we manipulated the availability of specific drink sizes, with the only difference being that participants saw five different drink size conditions. As shown in table 2, in addition to the core, low, and high conditions they also saw a full condition, which contains the core drinks along with the 12-ounce and the 44-ounce sizes, and a split condition, which drops the 21 ounce from the full condition. We use the split condition to test the effects of dropping a nonextreme option.

As before, each drink condition was fully crossed with the restaurant and visit order variables. In addition, participants on the ninth trip were provided calorie information on the items in the menu. This trip was crossed with the drink condition. We test to see whether this information has a main or interaction effect on ounces purchased. We find no significant effects ($p = .74$ and $p = .44$, respectively), and thus we do not discuss this manipulation further, other than to note that information provision had no effect on quantity purchase behavior. Also, although prices were fixed for seven of the eight trips, we increased them by about 20 cents per drink size for one replication of the high condition, in order to observe whether our participants respond to lower prices. As might be expected we observed a small downward shift in sizes purchased, indicating that the participants were aware of the prices charged. Furthermore, we replicated two drink conditions, the core and full conditions.

After completing the virtual road trip, participants were presented with 10 "standard" conjoint choice tasks to more precisely estimate the potential effect of price on the choice of drink size. The participants were asked to choose among either three or four sizes of their favorite soft drink, along with the no-choice option. The specific choice sets and prices varied between 35 and 45 cents per size, and the price differential between a size and the next highest size varied by as much as 40 cents. For example, one choice set consisted of a 16-ounce drink for $1.49, a 21-ounce drink for $1.69, and a 44-ounce drink for $1.75. Another consisted of a 12-ounce drink for $1.39, a 21-ounce drink for $1.59, and a 32-ounce drink for $1.69. In each case the participants chose their preferred drink size or the no-drink option.

National Sample Study Results

This within-subject-designed experiment allows us to obtain a more nuanced view of the compromise effect than can be obtained from analyzing aggregate market share changes as a function of the available drink sizes. This is important since multiple types of individual level behavior could lead to the same aggregate level results (Hutchinson et al. 2000; Wernerfelt 1995). For example, in table 1 we note that when we compare the core-condition market shares with those found in the low condition, we find an approximately proportional increase in the 16- and 21-ounce market shares, a condition that according to Simonson and Tversky's (1992) method of calculating extremeness aversion indicates no significant extremeness aversion. However, these aggregate data also could have occurred by having all the 12-ounce drinkers switch to the 16-ounce drink and approximately 50% of the initial 16-ounce drinkers switch to the 21-ounce drink. This latter explanation is compatible with extremeness aversion, that is, some 16-ounce drinkers switch to avoid the smallest size drink, while the proportional explanation is more compatible with a general attraction model of behavior.

This inability to differentiate between these two explanations leads us to examine individual switching behavior in order to assess the effects of the different drink formats on purchase behavior. We do this by examining if and when consumers switch their choice of drinks, depending on the portfolio of the drink sizes available. To give the reader a feel for this individual level switching behavior, we compare the purchase behavior of participants when faced with the core set of drinks and the low set, which also includes a 12-ounce drink. If there is no context effect present, standard economic reasoning predicts that the only systematic changes in purchase behavior would come from customers who chose the 12 ounce when it was available since they must either choose another size or not purchase a drink at all. In our sample there were 111 participants who purchased a 12-ounce drink when the low set was available. When the 12-ounce drink was not available, only 4% of these 111 participants decided not to buy a drink, while 94% purchased the next largest drink (i.e., the 16 ounce), and the remaining 2% purchased one of the two larger sizes. Such behavior is compatible with rational value maximization and the concept that consumers derive positive value from more than one soft drink. One might postulate that this effect is due to consumers' tendency to move up when their preferred option is no longer available. However, we did not observe this tendency when we dropped the 21-ounce drink from the portfolio. In that case 49% increased their purchase

TABLE 2

DRINK PORTFOLIO CONDITIONS: FOR THE NATIONAL SAMPLE ROAD TRIP TASK

	12 oz.	16 oz.	21 oz.	32 oz.	44 oz.
Conditions:					
Core		x	x	x	
High		x	x	x	x
Low	x	x	x	x	
Full	x	x	x	x	x
Split	x	x		x	x
Prices	$1.14	$1.44	$1.64	$1.84	$1.99

NOTE.—Prices listed are for the virtual road trip task. The prices for the conjoint task varied.

quantity, and the remaining percentage decreased their purchase quantity.

To investigate extremeness aversion we look at the 102 people who chose the 16-ounce size in the low condition and examine what they purchased when they were in the first core condition since in this condition the 16-ounce drink size was the smallest option available. Consistent with our McDonald's study results on the reliability of purchase behavior, we find that 73% of these consumers repeated their purchase of the 16-ounce drink. However, 23% increased their consumption by shifting to the 21-ounce drink. This latter behavior is not compatible with value maximization since their initial 16-ounce choice was still available. However, it is compatible with extremeness aversion. Similarly, when we compare the purchase behavior of consumers who purchased a 32-ounce drink when there is a 44-ounce drink available with their behavior when the 44-ounce drink is dropped, we find 28% of these initial purchasers of the 32-ounce drink switching to the 21-ounce drink, a behavior consistent with extremeness aversion.

Although these observed switching patterns could be attributed to extremeness aversion, they also could be due, at least in part, to the fact that our participants did not always purchase the same size drink on each restaurant visit. Consequently, any analysis aimed at quantifying the magnitude of extremeness aversion should control for systemic unreliable purchase behavior. We do this by pooling data in which the participants do not see any format changes with data associated with a format change. Our dependent variable is the change in quantity purchased from one occasion to another. Conceptually, we capture any systematic unreliability from those paired observations in which the format does not change. Similarly we estimate the effect of a format change from those paired observations associated with a particular change in format (e.g., going from the core to low).

Our coding is as follows. The identity of the size selected the first time in a pair is designated as a series of main effect dummy variables. In addition, these main effect variables are crossed with each format change. Thus, the estimates for the unreliable behavior are the main effect coefficients as shown in table 3, and the effects of any format change on switching from the first size purchased within the pair are captured in the interactions. We note that the main effect coefficients for the smaller sizes (12 and 16 ounces) have positive values and that the larger sizes (32 and 44 ounces) have negative values, indicating a systematic tendency to regress to the mean. Including this effect allows us to determine whether extremeness aversion exists after controlling for this tendency.

The next set of estimates measures the impact on purchase quantity when the 12-ounce drink was dropped, that is, the average change in quantity purchased going from the full to the high set. Now the 16-ounce drink becomes the smallest drink available. We first note that those participants who initially purchased a 12-ounce drink increased their consumption by an average of 2.86 ounces ($p = .0001$) after adjusting for any increase associated with a regression to the mean. This increase makes intuitive sense since the 12-ounce drink is no longer available, and participants either have to move to a larger drink size or not purchase a drink. Next we look at those participants who initially purchased a 16-ounce drink. Since it is now the smallest size, extremeness aversion would predict that some of these participants would move to the next size, thus increasing the average consumption for these initial 16-ounce drinkers. This is what we observe, with the average consumption increasing by 1.33 ounces ($p < .025$) again after controlling for any tendency to regress to the mean. Conversely, when we look at the change estimates associated with adding a 12-ounce drink (making the 16-ounce drink no longer the smallest drink available and thus more attractive to anyone who is averse to the smallest size), we note participants who initially bought the 21-ounce drink decreasing their purchase quantity by a marginally significant average of 1.49 ounces ($p < .06$). Analogous findings are seen when we look at adding and dropping the 44-ounce drink. Thus, dropping the 44-ounce drink should make the 32-ounce drink less attractive to consumers who initially purchase this size, if these consumers are averse to purchasing the largest drink available. We observe this extremeness aversion, with the average consumption for the initial 32-ounce drinker decreasing by an adjusted 2.58 ounces ($p < .03$). Finally, add-

TABLE 3

NATIONAL SAMPLE: EXTREMENESS AVERSION RESULTS

Parameter	Estimate	*t*-value
Effect of systematic unreliability:		
None	5.80	10.61
12 oz.	1.18	2.17
16 oz.	.20	.61
21 oz.	−.56	−1.00
32 oz.	−3.38	−5.33
44 oz.	−7.29	−6.37
Different format changes:		
Drop 12 oz. effect:		
12 oz. × drop 12 oz.	2.86	3.73
16 oz. × drop 12 oz.	1.33[a]	1.99
21 oz. × drop 12 oz.	.76	.75
32 oz. × drop 12 oz.	4.04	3.18
44 oz. × drop 12 oz.	.04	.03
Add 12 oz. effect:		
16 oz. × add 12 oz.	−2.91	−5.49
21 oz. × add 12 oz.	−1.49[a]	−1.59
32 oz. × add 12 oz.	−1.25	−1.24
Drop 44 oz. effect:		
12 oz. × drop 44 oz.	−1.03	−1.34
16 oz. × drop 44 oz.	−.98	−1.46
21 oz. × drop 44 oz.	−.84	−.83
32 oz. × drop 44 oz.	−2.58[a]	−2.03
44 oz. × drop 44 oz.	−8.21	−5.07
Add 44 oz. effect:		
16 oz. × add 44 oz.	.17	.31
21 oz. × add 44 oz.	1.05[a]	1.12
32 oz. × add 44 oz.	6.63	6.61

NOTE.—Estimated change in purchase quantity is for those who initially purchased a given drink size.
[a]Estimates given extremeness aversion; one-tailed test.

ing the 44 ounces should make the 32-ounce drink more attractive to the 21-ounce consumer since it now is no longer the largest drink available. In this case we note an increase of 1.05 ounces, although this increase is not highly significant ($p = .13$).

It is worth noting that this analysis makes no distinction between diet and nondiet consumers. When we regress ounces purchased as a function of drink condition and whether the participant is a diet drinker, we find diet drinkers actually purchase .97 ounces more ($p < .0001$). However, this increase is not a function of the drink condition ($p < .72$).

In summary, even after adjusting for any systemic switching that is due to inconsistency, we find that the individuals' switching behavior is consistent with the premise that some consumers alter their purchase behavior to avoid the largest or smallest drink size. Although this effect has been shown before using aggregate data, we believe our analyses to be of interest for three reasons. First, this is the first time the compromise effect has been shown at the individual level. This is important since it avoids any issues of aggregation bias (Hutchinson et al. 2000). Second, in our setting, participants were very familiar with all the alternatives in the possible choice sets. Therefore, observed context effects occur despite our consumers' solid familiarity with the decision setting. Finally, our analysis approach provides a strategy for controlling for inconsistency in purchase behavior while still being able to document the magnitude of the compromise effect using within-subject data. We next use this individual level data to develop a model of drink size choice that takes into consideration not only the individual's tastes for different sizes of drinks and the person's sensitivity for price but also the person's aversion for purchasing the smallest or largest size available.

INDIVIDUAL CHOICE MODEL

Overview

The work of Kivetz, Netzer, and Srinivasan (2004) postulates four possible models designed to capture consumers' extremeness aversion. These models are predicated on the assumption that preference for a desired attribute consistently increases with the level of the attribute (i.e., each attribute is a vector attribute). These researchers estimate their models in two stages. In the first they ask participants to complete a conjoint task similar to the one used in our studies. They use these data to estimate a utility model for each individual. Then in a second stage, they estimate one population level parameter per attribute that, in effect, reduces the individual's utility of the attributes near the extremes and increases it near the middle. More technically, the parameter makes all functions more concave, and as a result the middle attribute levels become more positive, relative to the two extreme values.

We generalize their approach by allowing the impact of extremeness aversion to differ for each individual. Thus, instead of assuming that consumers are homogeneous with respect to extremeness aversion, we allow each consumer to have his or her own extremeness aversion parameters. We also simplify the model by making the effect of aversion additive by introducing two terms, one for the smallest and one for the largest option in a given choice set. Specifically, we define individual i's utility for drink size j in choice set k to be defined as

$$U_{ij|k} = V_{ij} + \lambda_i \min_{j|k} + \gamma_i \max_{j|k} + \tau_i p_j + \varepsilon_{ijk}, \quad \textbf{(1)}$$

where V_{ij} is the individual's valuation for drink size j. Furthermore, min and max are dummy coded variables indicating whether size $j^{j|k}$ is the minimum or maximum in the kth choice set, and p_j is the price of the drink. The coefficients λ_i and γ_i capture the effects of being the smallest and largest option, respectively, and τ_i is the individual's price sensitivity. We follow the lead of Kivetz et al. (2004) and assume that the value of a larger size drink is greater than for a smaller size drink (holding fixed price and context). We capture this ordering of the V_{ij}'s as follows:

$$V_{ij} = \beta_{i12} x_{12} + \sum_{t=16}^{j} x_t e^{\beta it}, \quad \textbf{(2)}$$

where β_{i12} is an individual's parameter for a 12 ounce, $e^{\beta it}$ is the incremental value of a drink size greater than a 12 ounce, and x_t is a dummy variable, coded one if the drink size is smaller than or equal to size j. For example, the value for a 21-ounce drink size is

$$V_{i21} = \beta_{i12} x_{12} + x_{16} e^{\beta i_{16}} + x_{21} e^{\beta i_{21}}, \quad \textbf{(3)}$$

where x_{12}, x_{16}, and x_{21} are equal to one. We also assume that consumers value a lower price over a higher price. These assumptions are often used in economic modeling (Ratchford and Gupta 1990). Also, we assume that consumers select the option with the highest utility as long as the value of purchasing a soft drink is greater than not purchasing a drink at all. Finally, size choice is captured with a logit choice model implying that the error term is distributed Weibull.

We estimate the parameters (β_{ij}'s, λ_i, γ_i, and τ_i) using hierarchical Bayes (Rossi, Allenby, and McCulloch 2005; Train 2003). It is convenient to assume normal priors for each parameter during estimation. Consequently, each of the parameters can take on both positive and negative values. Equation 2 allows for this and still ensures the proper ordering of the individual V_{ij}'s. The estimation uses data from six road trips and the conjoint data. We use the remaining road trips as a holdout sample to allow us to assess the predictive validity of our model. This hierarchical Bayes estimation approach has a number of benefits over standard conjoint analysis. First, instead of estimating a contextual parameter that is the same across the population, it allows each respondent to have an individual parameter. Second, this technique does not require the number of choice alter-

TABLE 4

NATIONAL SAMPLE: POPULATION MEAN UTILITY ESTIMATES AND STANDARD DEVIATIONS

Variable	Mean (1)	Mean iteration SD (2)	Individual level SD (3)
Value (V_{ij}):			
12 oz.	11.38	.35	3.39
16 oz.	16.48	1.23	8.70
21 oz.	21.37	2.03	16.23
32 oz.	24.16	2.36	21.95
44 oz.	24.20	2.36	21.94
Price sensitivity (τ..)	−8.52	.25	1.92
Smallest size (λ..)	.39	.10	1.95
Largest size (γ..)	−1.79	.23	2.00

NOTE.—Mean iteration SD is the standard deviation across the iteration means. Individual level SD is the standard deviation across each individual's mean. It is indicative of the heterogeneity across participants.

natives to be constant across all choice opportunities; thus, the road trip choice data can be combined with the conjoint data in order to estimate the utility function. Finally, it uses information from all of the participants in developing a given participant's estimates leading to more efficient estimates.

Before discussing the results, we note that the hierarchical Bayes estimation approach does not provide us with one point estimate for each of our parameters but instead provides a posterior distribution for each parameter. This is due to the fact that the parameters are estimated using an iterative approach. We used 50,000 iterations to ensure convergence and use the last 9,000 to estimate the posterior distributions.

Thinning these posterior estimates every tenth draw, we use 900 estimates to assess the accuracy of our context dependent model by comparing the choices based on these individual level estimates with each participant's actual holdout choices from the road trip. We predict choice correctly 68% of the time. This percentage is compared to the upper limit of prediction, the base rate of 77%, which represents the percentage of time our national sample of respondents made the same choice when faced with the same set of prices and drink options. Next we compare this percentage to the naive model of 46%, which represents the percentage of time a prediction would have been correct if the model was to indicate the size with the maximum market share. Finally, we compare our context dependent model with the context-free model in predicting the two holdout choices for each individual for each iteration of our estimation using the logarithmic scoring rule (Bernardo and Smith 2000; Jose, Nau, and Winkler, forthcoming). We find that the mean score for our context dependent model significantly improves predictability ($p < .001$). These comparisons indicate that our model is a reasonable representation of our participants' choice behavior.

To provide a feel for the variation in estimation across the sample, we report in table 4 the population mean values (col. 1), which are the average of each respondent's mean value for that parameter, along with the population standard deviations of these mean values across iterations (col. 2) and the average standard deviations of the means across individuals (col. 3). The first set of standard deviations implies reasonable stability of our population mean estimates, while the latter set of standard deviation estimates reflects the considerable heterogeneity within our sample population. For example, these latter standard deviation estimates imply that about 80% of our sample has an aversion for the largest size and nearly half has an aversion for the smallest size. This is confirmed in figure 4, where we plot the actual distribution of the extremeness aversion parameters across our sample.

Although population averages are of some interest, our primary interest is in being able to understand each individual's choice. To obtain a feel for these estimates and understand how an individual's choice may change when the drink size offering changes, table 5 provides the mean values for participant 92. This individual is averse to both the smallest (−1.66) and largest extreme (−.51), with the greatest aversion for the smallest drink size. In addition, we see that this individual derives positive utility from each drink size and negative utility from increases in price.

Note that drink sizes are not available in a context-free environment. Consequently, it is necessary to augment these values with the estimates for the (dis)utility of being the smallest or largest drink size as well as the cost of the particular drink size. For example, table 6 shows participant 92's estimated utility in two different contexts. In the second column this participant sees drink sizes range from 12 to 44 ounces. In the third column, the 12-ounce drink is dropped. Based on this person's context-free utility values and the person's disutility for price and the two extreme options, this participant would most likely purchase the 16-ounce drink when the 12-ounce drink is available, but when the 12-ounce drink is removed, this person would switch to a 21-ounce drink. It is this underlying mechanism of extremeness aversion that results in many of the participants switching their size choices when the portfolio of drink sizes is altered.

Focal Restaurant Study—Policy Experiments

In this analysis we take the perspective of a local fast food restaurant responding to the demand of its target au-

FIGURE 4

DISTRIBUTION OF EXTREMENESS AVERSION PARAMETERS

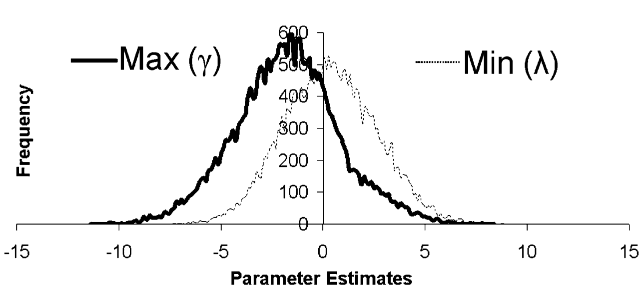


TABLE 5

EXAMPLE INDIVIDUAL (NO. 92): MEAN UTILITY ESTIMATES AND STANDARD DEVIATIONS ACROSS ITERATIONS

Variable	Mean	SD
Value (V_{92j}):		
12 oz.	7.80	2.33
16 oz.	9.54	2.91
21 oz.	10.28	3.27
32 oz.	10.81	3.32
44 oz.	10.85	3.32
Price sensitivity (τ_{92})	−6.42	2.03
Smallest size (λ_{92})	−1.66	.73
Largest size (γ_{92})	−.51	.90

dience and assess policy restrictions that might be placed on it by the government. To characterize the demand function facing the local restaurant, we sampled 178 young adults who represented the relevant market for a local fast food restaurant. Using the same methodology as presented in the national sample study, we measured each participant's purchase behavior and then used these responses to obtain individual level parameter estimates. We lastly used these estimates to illustrate how to assess the response of a firm to a number of policies aimed at reducing soft drink volume consumption and thus consumers' weight.

One might claim that such a reduction in drink consumption would have only a minimal impact on helping address the current obesity problem. However, changing one aspect of a consumer's behavior can have a substantial impact in the long run (CDC 2006b; Cutler et al. 2003). As noted earlier, switching from a 21- to a 32-ounce soft drink results in a consumer gaining approximately 8 pounds a year if this person consumes one nondiet soft drink a day. Take, for instance, a 25-year-old male of average weight and assume that he maintains his activity level over the next 5 years. If this person were to switch from a 21- to a 32-ounce drink, he would be overweight before age 30 and obese by 35. Moreover, this seemingly harmless extra 121 calories a day is likely to go unrecognized. It is just a single size increase. Consequently, modeling these effects allows us to access different policies on consumption in addition to firm performance.

Most policy interventions proposed by medical experts and politicians have centered on taxing junk food and soft drinks, pointing to the success of Florida's 76-cent-per-pack tobacco tax that led to a 10% reduction in cigarette consumption over 3 years (Gruber 2001). Globally, we note that the World Health Organization has proposed to tax unhealthy foods at the national level (Ritter 2006; World Health Organization 2003). In the United States, over a dozen states have instituted a soft drink tax, with many other states considering doing the same. Nationally, the American Medical Association has considered lobbying Congress for federal level taxation on soft drinks (Jones 2003). Many in the public health arena have strongly proposed taxation of unhealthy foods but have not specified a tax rate (Battle and Brownell 1996; Marshall 2000; Nestle 2002). However some evidence suggests that taxation would have little impact on consumers' diets (Kuchler, Tegene, and Harris 2004).

We discuss an alternative policy that also has the potential of addressing the issue of soft drink consumption. This approach sets per-customer targets for firms based on the average soft drink volume per customer but does not say how firms need to go about meeting these targets. In this way it is similar to the corporate average fuel economy (CAFE) standard found in the automobile industry. Under CAFE, each individual car sold does not have to meet the fuel efficiency standard; however, the auto manufacturer is responsible for its fleet average meeting the fuel efficiency standard. Enactment of CAFE in the United States has been credited with doubling fuel efficiency between 1975 and 1989 (Hafemeister 2007). One could imagine a similar standard for the fast food industry in which firms would manage to an average drink-size-purchased target. Firms would be free to decide on the portfolio of drink sizes they would like to offer and what prices they would like to charge, given the competition and standard.

We compare the outcome of a CAFE-like standard with two potential consumption tax policies. Using our understanding of consumers' preferences for different size drinks and their aversion to the smallest and largest sizes within a portfolio, we show that this standard setting reduces consumption up to 14% with minimal financial impact on consumers. This minimal impact on consumers is important since a valid criticism of taxation is that it imposes most heavily on low income individuals. Additionally, we give evidence that this standard-setting approach is more acceptable to fast food firms since it gives them the freedom to set prices and assortments, which has less impact on the bottom line.

Before presenting our results, we briefly describe the procedure used in our policy simulations (see the appendix for more technical details). Each simulation starts with a specific environment (i.e., a set of prices and a portfolio of available drink sizes). We then use our estimates of the effects of price, drink sizes, and size aversion to predict each individual's drink size choice given this environment. These choices are then aggregated to estimate demand for each drink size from which we calculate firm profits and total consumption. We then use the generalized reduced gradient

TABLE 6

EXAMPLE INDIVIDUAL (NO. 92): UTILITY FOR 12–44 OZ. VERSUS 16–44 OZ.

Drink size	Full condition (12–44 oz.) U_{92j}	High condition (16–44 oz.) U_{92j}
12 oz.	−1.01	
16 oz.	.97	−.59
21 oz.	.38	.38
32 oz.	−.41	−.41
44 oz.	−2.30	−2.30

NOTE.—Utility is calculated using eq. 1.

(GRG) method (Lasdon et al. 1978) to alter this initial set of prices, holding fixed the portfolio of drink sizes, to find the combination of prices that maximizes the firm's profits. We repeat this total process 90 times using a different draw from the posterior distribution of parameter estimates for each individual in our sample. Through this process we empirically determine the posterior distribution of profits for the profit-maximizing firm, conditional on the assumed portfolio of drink sizes and our understanding of the underlying consumer demand. In the following discussion, we report the mean values associated with these posterior distributions.

As with most simulations, our results are contingent on our underlying assumptions. First, we assume that our sample is representative of the soft drink population facing the local restaurant and that the soft drink assortment does not alter the likelihood that a person will enter the restaurant. Furthermore, we assume that each respondent chooses the one drink size option (including the no-drink option) that maximizes the individual's utility. If customers do not purchase a drink, we assume that they will choose a cup of water for which there is no charge to the customer. We also assume that drink consumption and the cost of the drink do not affect other food purchases. Finally, for the simulation we assess volume consumed without regard to whether it is a diet or a nondiet drink. We note that a substantial proportion (42%) of this sample purchased a diet drink. However, any policy on soft drinks would affect both the regular and diet drink sizes and prices. Consequently, we use all drinkers to show the effects of changes in the portfolio of drinks. Of course any calorie changes will only occur for those consumers who actually purchase nondiet drinks.

From the retailer's perspective, we assume that the outlet offers only standard drink sizes (i.e., 12, 16, 21, 32, or 44 ounces) since these are the standard cup sizes available from drink cup suppliers. We here confine the retailer's choice of drink sizes to one of the four portfolio sets (core, low, high, and full). However, we let the firm set the price for each size subject to two constraints that reflect our knowledge of the current marketplace and the internal cost structure of fast food establishments. First, with each increase in size, there must be a price increase that is at least as great as the increase in marginal costs associated with the larger size. These costs are close approximations to the local restaurant's current costs of the liquid syrup and materials that go with each drink size. More specifically we assume at least a 10-cent increase in price between the 12- and 16-ounce drink sizes and the 16- and 21-ounce drink sizes, as well as 20-cent increases between the 21-, 32-, and 44-ounce drinks. Second, we assume that the price for 44 ounces will be no higher than $1.89 since we currently do not observe prices higher than this in our fast food marketplace. Finally, we assume that the retailer's goal is to maximize profits and that the retailer will choose the portfolio of drinks that yields the highest profits per customer under any given policy. These assumptions mimic the behavior of a profit-maximizing firm acting as a partial monopolist, that is, one facing pricing constraints brought on by competition, internal costs, and possible government policy. We believe that these assumptions closely approximate the current fast food environment, but we will later discuss the robustness of our results to different assumptions.

Table 7 displays, for a number of different policy conditions, the firm's average profit per customer, average soft drink consumption levels, and market shares for each drink size for each of the four drink portfolios. We first consider the base case where there are no policy restrictions. In this nonregulation/standard-setting environment, the high condition, that is, the 16–44 ounce portfolio of drinks, yields the highest revenue and profit per customer. In contrast, the low drink portfolio that drops the 44-ounce and adds the 12-ounce size yields the lowest revenue and profit per customer. This result is consistent with the proposition that profit-maximizing fast food outlets have gradually increased portion sizes by dropping the otherwise popular 12-ounce drink and adding the otherwise unpopular 44-ounce drink. Part of the reason why we find this increase in profits is due to the fact that most people who initially would have bought the 12-ounce drink now prefer to buy the next largest size and, thus, pay more for a soft drink rather than not purchase a drink. This is expected based on what we know about rational utility. However, this is not the only reason. Adding the 44-ounce drink and dropping the 12-ounce drink changes the identity of the smallest and largest drinks available and thus shifts the demand of 16- and 21-ounce drinkers who exhibit extremeness aversion toward the higher-margin, larger drinks. Both factors imply that portion sizes and consumption will increase even though the consumers' underlying preference structures have not changed.

This quest for higher profits has a substantial impact on the volume consumed. Thus, when a firm changes from the low-condition to the high-condition portfolio, we estimate (per table 7) that our sample of consumers would show a 17% increase in consumption, going from an average of 17.7 ounces per customer to 20.6 ounces per customer. Note that this increase occurs even though these consumers' underlying context-free demand for a soft drink remains the same. We believe this finding is important since it clearly demonstrates how a very subtle consumer heuristic can interact with profit maximization for firms to have a major and unexpected impact on society.

Given these base-condition results, we compare the implications of the three policies and each of the drink conditions against the high-condition portfolio (16–44 ounce) since this portfolio of drink sizes maximizes the retailer's profits assuming no government or industry restrictions. Moreover, in order to facilitate comparisons, we assume that the policy maker's goal is to establish a policy that leads to an initial 10% reduction in consumption from this baseline condition, and we assess the impact on resultant offerings, prices, and profits.

Consider first the implications of a flat tax on every soft drink purchased. Firms still maximize their profits by adjusting prices and offerings but under the constraint of the

TABLE 7

POLICY EXPERIMENT RESULTS

Portfolio	Average profit per customer ($)	Average size (oz.)	Size % change	$ per customer	$ per customer % change	Market share (%)					
						None	12 oz.	16 oz.	21 oz.	32 oz.	44 oz.
Baseline:											
High (16–44 oz.)[a]	1.20	20.6		1.39		8		32	36	22	2
Full (12–44 oz.)	1.19	19.2	−7	1.38	−1	7	16	29	28	20	2
Core (16–32 oz.)	1.18	18.9	−8	1.36	−2	8		34	47	12	
Low (12–32 oz.)	1.18	17.7	−14	1.34	−3	7	17	31	34	11	
Flat tax:											
High (16–44 oz.)	1.06	18.5	−10	1.46	5	19		25	33	22	2
Full (12–44 oz.)[a]	1.12	17.2	−16	1.45	4	14	24	19	23	19	1
Core (16–32 oz.)	1.04	16.8	−18	1.42	2	20		26	43	11	
Low (12–32 oz.)	1.05	16.0	−22	1.44	3	17	14	26	32	10	
Graduated tax:											
High (16–44 oz.)	1.11	18.8	−9	1.43	3	15		32	32	21	1
Full (12–44 oz.)[a]	1.15	17.4	−15	1.43	3	12	16	31	23	17	1
Core (16–32 oz.)	1.10	17.1	−17	1.39	0	16		34	41	10	
Low (12–32 oz.)	1.12	16.1	−22	1.39	0	13	17	34	28	9	
CAFE-like standard:											
High (16–44 oz.)	.60	18.5	−10	.77	−44	1		76	11	11	1
Full (12–44 oz.)	1.14	18.5	−10	1.32	−6	5	26	28	22	18	2
Core (16–32 oz.)	1.12	18.6	−10	1.30	−7	6		46	37	11	
Low (12–32 oz.)[a]	1.18	17.7	−14	1.34	−4	7	17	31	34	11	

NOTE.—All results are based on firm response to the specific policy. Thus, the average size percent change may vary from the 10% target reduction.
[a]Profit-maximizing results.

tax. For our sample we find that this flat tax would have to be 28 cents per drink for consumption to be reduced by 10%, assuming the retail outlet offers the baseline portfolio of drink sizes. Because the flat tax encourages consumers who have the lowest valuation for a soft drink to either switch to a smaller drink size or drop out of the market, the percentage of people who do not buy a soft drink increases from 8% to 19%, and the average amount paid over all consumers (including those who do not purchase a drink) increases by 5%.

It is interesting to note that if such a flat tax were imposed, the profit-maximizing firm would no longer find it in its interest to offer the high (16–44 ounce) portfolio. Instead it would augment this portfolio by adding a 12-ounce drink, since profits are highest with this addition. If this change in portfolio occurred, consumption would decrease by a total of 15%. However, firm profits would still fall by 7% from the high condition (16–44 ounce), assuming no soft-drink-specific taxation.

Similar to a gas tax (i.e., the more one buys the more taxes paid), we next evaluate a graduated tax based on ounces of consumption. We again determine the tax needed to yield a 10% reduction from our baseline condition. As before, we initially assume firms react to this tax only by altering prices to maximize profits conditional on the tax. In this case, the needed tax would be 0.9 cents per ounce, resulting in a low of an 11-cent tax for the 12-ounce drink to a high of a 38-cent tax for the 44-ounce drink. Since this graduated tax has less impact on the smaller sizes, we find more consumers choosing a soda (85% compared to 81% for the flat tax). Moreover, the higher tax on the larger-sized drinks pushes consumers toward the lower-priced, smaller drinks. Finally we again note that under this tax policy, the retailer would offer a 12-ounce drink since profits are highest with the full (12–44 ounce) portfolio.

The two tax policies explored above rely on higher prices to reduce overall demand. As a by-product, both the flat tax and the graduated tax decrease firm profit, increase the number of customers priced out of the market, and increase the average price paid compared to the base case. Thus, the regulation has the intended effect on consumption but with substantial economic distortion. To limit that distortion, we next explore a CAFE-like standard in which firms would be held to an average drink size target. As before, we allow the profit-maximizing firm to set prices and select the product mix in response to the regulation. We find that under the baseline portfolio, the firm, in order to achieve a 10% reduction in volume, would need to drastically lower its price of the smallest drink size by almost 50%, thereby driving share from the larger drink sizes to the smaller drink sizes. Furthermore, we find it would need to lower all other prices except for the 32- and 44-ounce drink sizes. As a result almost all the consumers would buy a soft drink, the average price would decrease by 44%, and the retail soft drink profits would plummet by 50%.

Of course the profit-maximizing firm would not choose this option if faced with such a standard. Instead the firm would drop the 44-ounce drink from its portfolio and add a 12-ounce drink using extremeness aversion and consumers' desire to purchase a drink to help it drive down the average size of the drink. Comparing this solution to the two tax policies, we find that consumers pay less on average and that more consumers purchase a drink. Finally, even though the firm only needed to obtain a 10% reduction in consumption, this change in the portfolio results in a 14% reduction while profits fall by less than 2%.

DISCUSSION

The overarching theme of this article is to use existing consumer behavior theories and a new virtual shopping experiment to better understand how firms and policy makers might address the obesity problem by reducing the consumption of soft drinks within the fast food environment. This requires us to develop a methodology that can be used to quantify the degree to which consumers would respond to changes in offered sizes and prices. We start by recognizing the behavioral implications of extremeness aversion on consumers' choice of a soft drink size when buying from a portfolio of drink sizes. We quantify this extremeness aversion effect using three studies. The first links the virtual purchase behavior used in the second two studies to actual purchase and consumption behavior. The second study quantifies the magnitude of the aversion effect for a national sample of adult consumers, and the third documents how this effect could play out, given firm and consumer reactions to regulations.

Although this research is motivated by the obesity problem, we believe it appeals to a greater audience. To date, there have been few experimental or empirical investigations of extremeness aversion with choice sets that exceed three products. Moreover, almost all the modeling and estimation of this behavioral effect has been done at the aggregate level. In contrast, our experiments use a within-subject design and up to six product choices, including the no-choice option. These experiments not only provide additional evidence of extremeness aversion; they also enable us to measure the degree to which this aversion is common to all consumers. Interestingly we find just about a third of the participants in our different samples tended to avoid both of the extremes. In addition we find an individual's aversion to the smallest extreme often differs from his or her aversion to the largest extreme. Thus, our methodology not only allows us to better understand and model these complex individual reactions, but it also allows us to estimate the impact of both personal and policy decisions in ways that can be relevant to consumers, policy makers, and firms.

With regard to the policy experiments, we find that profit-maximizing firms currently find it in their best interest to carry the high portfolio of four drinks, that is, 16, 21, 32, and 44 ounces, and not offer the 12-ounce drink, even though, based on our purchase data, there appears to be a demand for this size. We believe that this has happened for two reasons. First, for those consumers who indicate they prefer a 12-ounce drink, the vast majority will purchase a larger size drink if the 12-ounce drink is not available. Consequently, the outlet does not lose many sales by dropping the smallest size. Second, by adding the 44-ounce and making the 16-ounce drink the smallest drink size, the outlet is able to shift the demand curve outward even though consumers' underlying (context-free) preferences have not changed. We believe this observation is new to the literature and represents an important insight as to why drink portion sizes have increased over time.

Our policy simulations also show that if the government imposes either a flat tax or a graduated tax sufficient enough to reduce volume, say by 10%, it is optimal for the firm to add a 12 ounce to its current portfolio of drinks. This is due to the fact that the firm can mitigate the loss of some of its beverage consumers from being priced out of the market. Thus, we find that these tax policies not only cause the firm's sales to "slide down the demand curve" due to the higher prices; they also cause the firm to change its portfolio of offerings resulting in an additional decline in consumption. Such analyses reveal complex interactions among policy, firm reactions, and consumer behavior as well as highlight the need for detailed analyses in order to determine any unanticipated side effects of a particular policy. Finally, we find a standard-setting policy based on average purchase levels per customer produces the desired volume reduction and the least negative impact on both firm profits and the consumer's ability to still buy a soft drink. If intervention is inevitable, we suspect firms and consumers would prefer such a solution since it reduces consumption with minimal firm and consumer impact. Moreover, as noted by Mazis et al. (1981), setting a standard often is more acceptable to firms since it reduces the need to compete on this dimension.

Although we demonstrated an almost profit-neutral outcome for fast food firms, this does not imply that the beverage firms will find any of these policies to be profit neutral. This is due to the fact that total soft drink consumption will be reduced. We acknowledge that our analysis does not take into consideration the downstream beverage firms' reactions to this inward shift in their demand curve. Standard economic theory predicts that they would lower the wholesale price of the soft drink syrup to the retail outlet, with the goal of getting the retailers to pass some of this reduced price onto the ultimate consumer, thereby increasing consumption. We suspect such a reduction in the wholesale price would have a small second-order effect on our results since the syrup costs are only a small portion of the total cost of the soft drink. Still, any impact on the beverage companies and the suppliers should be examined in order to gain a greater perspective on the economic impact of any policy actions.

We acknowledge that our experiments did not examine a tax on calories. Such a regulatory regime could shift sales from sugar to artificial sweeteners and should certainly be considered in any attempts to lower caloric intake. We chose not to consider differential incentives for diet drinks because in the current market both diet and regular drinks are equally available and equally priced. Our experiments only altered the prices and availabilities of the drinks in a way that appeared very natural to our respondents, as validated by the correspondence between the road trip simulation and actual choice in the pretest. We expect that altering the relative price and availability of diet versus regular sodas would be more challenging, but we leave that challenge to future research.

We also note that our research setting did not capture the fact that most national fast food firms offer bundled meals, more commonly known as "combo" or "value" meals. We expect that extremeness aversion affects such bundled meals in the sense that a drink portfolio that contains a very large drink size (e.g., 44 ounces) makes the standard bundle, which now contains a 21-ounce drink, seem less extreme. More important, it is likely that the size included in the standard bundle sets the size norm for the restaurant. Thus, increasing the bundled drink size from 16 to 21 ounces sets a norm for consumption that can have a substantial impact on sizes chosen in other contexts. Furthermore, it would be valuable to determine the mediating effects of bundling on (*a*) an individual's tendency to purchase more food and (*b*) how consumers who decide not to purchase the bundle are affected in terms of their purchase decisions.

We also acknowledge that some outlets allow the person to get a refill for free. We do not know the extent of this behavior (although our local restaurant manager estimated that 10% of customers obtain a refill), but given the research of Wansink and colleagues (Wansink 1996; Wansink and Kim 2005; Wansink and Park 2001) on the effects of container size and consumption, we expect that the changes predicted in this research would be directionally in line with our work, even in the case of refills. Still, measuring the effect of refills might be an interesting future research topic.

We note that we assumed firms had perfect knowledge with respect to their underlying demand. One might imagine a scenario in which they had no better information than we, as researchers, did with respect to an individual's value function. In such a situation the firm would have to set prices based on the distribution of possible demands versus the actual demand. We replicated our analyses using the less than full information assumption and found almost no differences to our table 7 results. Thus, we believe our results are robust to this underlying (and difficult to verify) assumption.

Additionally, from a policy perspective, there is the issue of implementation and monitoring. In the case of a flat tax policy, firms would have to report the number of drinks sold to determine the total tax due. Alternatively, for a graduated tax, firms would need to submit the amount of ounces sold. The CAFE-like standard would require the most information. First, firms would need to submit the total number of customers (estimated by, say, the number of entrées sold) as well as the number of drinks sold by size. Thus, the average volume sold could be computed. Although this scheme is slightly more burdensome, most fast food firms already record sales by different drink sizes, information needed not only for firm level sales reporting but also for inventory-tracking purposes. Consequently, the raw data needed to monitor the firm's performance can be obtained from the firm's current point-of-sales accounting system.

Finally, there is the issue of whether extremeness aversion sustains over time. We believe it does, as shown by the persistent increase in consumption as the size offerings have increased over time in the fast food industry. People adapt to sizes and see others consuming such sizes, and soon new sizes become the norm. Our simulation has shown it is advantageous for the profit-maximizing retailer to increase the average size. While there is still empirical work needed to determine the extent to which extremeness aversion continues to alter multiple choices from the same portfolio of sizes, we hope we have shown that business and policy decisions that do not consider choice context will be systematically flawed.

APPENDIX

POLICY OPTIMIZATION TECHNICAL DETAILS

With regard to optimization, the GRG method is a nonlinear extension of the linear simplex method of iteratively finding an optimum (Lasdon et al. 1978). The basic approach taken is to select a point, determine a search direction and distance, and solve a system of equations at each step to maintain feasibility. A nonlinear technique is necessary because we use the nonlinear logit formulation to calculate the probability of individual i choosing size j given the set k as follows:

$$\Pr_i(j|k) = \frac{\exp(V_{ij} + \lambda_i \min_{jk} + \gamma_i \max_{jk} + \tau_i p_j)}{\sum_{j=min}^{max} \exp(V_{ij} + \lambda_i minjk + \gamma_i maxjk + \tau_i p_j)} \quad \textbf{(A1)}$$

We then use this probability function to calculate the share $S_{j|k}$ for each size j conditional on the offering set k across all N individuals:

$$S_{j|k} = \frac{\sum_{i=1}^{N} \Pr_i(j|k)}{N}. \quad \textbf{(A2)}$$

This share is used to determine the expected profit per customer (*expected profit*, hereafter) and the expected ounces per customer (*expected ounces*, hereafter). The firm's expected profit conditional on the offering set k is the sum of the margin for each drink size times the share j:

$$E(\text{profit}|k) = \sum_{j=min}^{max} (p_j - c_j) \times S_{j|k}, \quad \textbf{(A3)}$$

where p_j is the price and c_j is the wholesale cost of size j.

The expected ounces is the average volume per customer, that is,

$$E(\text{ounces}|k) = \sum_{j=min}^{max} (j) \times S_{j|k}. \quad \textbf{(A4)}$$

Note that embedded in both the expected profits and the expected ounces is the nonlinear probability function. Price is manipulated via the GRG method to maximize expected profit.

REFERENCES

Battle, E. Katherine and Kelly D. Brownell (1996), “Confronting a Rising Tide of Eating Disorders and Obesity: Treatment vs. Prevention and Policy,” *Addictive Behaviors*, 21, 755–65.

Bernardo, Jose M. and Adrian F. M. Smith (2000), *Bayesian Theory*, West Suffix: Wiley.

Bettman, James R., Mary Frances Luce, and John W. Payne (1998), “Constructive Consumer Choice Processes,” *Journal of Consumer Research*, 187–217.

Burton, Scot, Elizabeth Creyer, Jeremy Kees, and Kyle Huggins (2006), “Attacking the Obesity Epidemic: An Examination of the Potential Health Benefits of Nutrition Information Provision in Restaurants,” *American Journal of Public Health*, 96 (9), 1–6.

CDC (Center for Disease Control and Prevention) (2001), “Physical Activity Trends: United States, 1990–1998,” *Morbidity and Mortality Weekly Report*, 50 (9), 166–69.

——— (2006a), DATA2010: The Healthy People 2010 Database, http://wonder.cdc.gov/data2010.

——— (2006b), “Overweight and Obesity: Contributing Factors,” http://www.cdc.gov/nccdphp/dnpa/obesity/contributing_factors.htm.

Chandon, Pierre and Brian Wansink (2007a), “Health Halos: How Health Claims Bias Calorie Estimations and Lead to Overeating,” *Journal of Consumer Research*, 34 (October), 301–13.

——— (2007b), “Is Obesity Caused by Calorie Underestimation? A Psychophysical Model of Fast-Food Meal Size Estimation,” *Journal of Marketing Research*, 44 (February), 84–99.

Cutler, David M., Edward L. Glaeser, and Jesse M. Shapiro (2003), “Why Have Americans Become More Obese?” working paper, National Bureau of Economic Research, Cambridge, MA.

Dhar, Ravi and Itamar Simonson (2003), “The Effect of Forced Choice on Choice,” *Journal of Marketing Research*, 40 (2), 146–60.

DHHS (Department of Health and Human Services) (2001), *The Surgeon General’s Call to Action to Prevent and Decrease Overweight and Obesity*, Rockville, MD: Office of the Surgeon General, U.S. Department of Health and Human Services.

Finkelstein, Eric A., Ian C. Fiebelkorn, and Guijing Wang (2003), “National Medical Spending Attributable to Overweight and Obesity: How Much, and Who’s Paying?” *Health Affairs*, 22, 219–26.

Fisher, Jennifer O., Barbara Rolls, and Leann L. Birch (2001), “Effects of Repeated Exposure of Large Portion-Sized Entrée on Children’s Eating,” *Obesity Research*, 9, 76S.

——— (2003), “Children’s Bite Size and Intake of an Entrée Are Greater with Large Portions than with Age-Appropriate or Self-Selected Portions,” *American Journal of Clinical Nutrition*, 77, 1164–70.

Freedonia Group (2007), “Soft Drink Production,” industry report, OneSource global database, http://www.onesource.com/.

Geier, Andrew B., Paul Rozin, and Gheorghe Doros (2006), “Unit Bias,” *Psychological Science*, 17 (6), 521–25.

Gruber, Jonathan (2001), “Tobacco at the Crossroads: The Past and Future of Smoking Regulation in the U.S.,” *Journal of Economic Perspectives*, 15 (2), 193–212.

Hafemeister, David W. (2007), *Physics of Societal Issues: Calculations on National Security, Environment, and Energy*, New York: Springer, 378–96.

Hutchinson, J. Wesley, Wagner A. Kamakura, and John G. Lynch Jr. (2000), “Unobserved Heterogeneity as an Alternative Explanation for ‘Reversal’ Effects in Behavioral Research,” *Journal of Consumer Research*, 27 (December), 324–44.

Jones, Adam (2003), “WHO Calls for Taxes to Combat Obesity,” *Financial Times* (December 4).

Jose, Victor Richmond, Robert F. Nau, and Robert L. Winkler (forthcoming), “Scoring Rules, Generalized Entropy, and Utility Maximization,” *Operations Research*.

Kivetz, Ran, Oded Netzer, and V. Srinivasan (2004), “Alternative Models for Capturing the Compromise Effect,” *Journal of Marketing Research*, 41 (August), 237–57.

Kral, Tanja V. E., Liane S. Roe, Jennifer Meengs, Denise E. Wall, and Barbara Rolls (2002), “Increasing the Portion Size of a Packaged Snack Increases Energy Intake,” *Appetite*, 12 (1), 69–74.

Kral, Tanja V. E., Liane S. Roe, and Barbara Rolls (2004), “Combined Effects of Energy Density and Portion Size on Energy Intake in Women,” *American Journal of Clinical Nutrition*, 79 (6), 962–68.

Kruger, Jose A., Sandra A. Ham, and Harold W. Kohl III (2005), “Trends in Leisure-Time Physical Inactivity by Age, Sex, and Race/Ethnicity: United States, 1994–2004,” *Morbidity and Mortality Weekly Report*, 54 (39), 991–94.

Kuchler, Fred, Abebayehu Tegene, and J. Michael Harris (2004), *Taxing Snack Foods: What to Expect for Diet and Tax Revenues*, Agricultural Information Bulletin: Current Issues in Economics of Food Markets, Washington, DC: Economic Research Service, U.S. Department of Agriculture.

Lasdon, Leon S., Allan D. Waren, Arvind Jain, and Margery W. Ratner (1978), “Design and Testing of a Generalized Reduced Gradient Code for Nonlinear Programming,” *ACM Transactions on Mathematical Software (TOMS)*, 4 (1), 34–50.

Levitsky, David A. and Trisha Youn (2004), “The More Food Young Adults Are Served, the More They Overeat,” *Journal of Nutrition*, 134, 2546–49.

Marshall, Tom (2000), “Exploring a Fiscal Food Policy: The Case of Diet and Ischaemic Heart Disease,” *British Medical Journal*, 29 (January), 301–4.

Mazis, Michael B., Richard Staelin, Howard Beales, and Steven Salop (1981), “A Framework for Evaluating Consumer Information Regulation,” *Journal of Marketing*, 45 (Winter), 11–21.

Menon, Satya and Barbara E. Kahn (1995), “The Impact of Context on Variety Seeking in Product Choices,” *Journal of Consumer Research*, 22 (3), 285–95.

Moorman, Christine (1996), “A Quasi-Experiment to Assess the Consumer and Informational Determinants of Nutrition Information Processing Activities: The Case of the Nutrition Labeling and Education Act,” *Journal of Public Policy and Marketing*, 15 (Spring), 28–44.

Nestle, Marion (2002), *Food Politics: How the Food Industry Influences Nutrition and Health*, Berkeley: University of California Press.

Nielsen, Samara J. and Barry M. Popkin (2003), "Patterns and Trends in Portion Sizes, 1977–1998," *Journal of the American Medical Association*, 89 (4), 450–53.

Nisbett, Richard E. (1968), "Determinants of Food Intake in Human Obesity," *Science*, 159, 1254–55.

Nowlis, Stephen M., Barbara Kahn, and Ravi Dhar (2002), "Coping with Ambivalence: The Effect of Removing a 'Fence Sitting' Option on Consumer Attitude and Preference Judgments," *Journal of Consumer Research*, 29 (3), 319–35.

Ratchford, Brian and Pola Gupta (1990), "On the Interpretation of the Price-Quality Relationship," *Journal of Consumer Policy*, 13 (4), 389–411.

Ritter, Jim (2006), "Just What the Doctor Ordered: A Soda Tax?" *Chicago Sun-Times* (June 11).

Rolls, Barbara J., Dianne Engell, and Leann Birch (2000), "Serving Portion Size Influences 5-Year-Old but Not 3-Year-Old Children's Food Intakes," *Journal of the American Dietetic Association*, 100 (2), 232–34.

Rolls, Barbara J., Erin L. Morris, and Liane Roe (2002), "Portion Size of Food Affects Energy Intake in Normal-Weight and Overweight Men and Women," *American Journal of Clinical Nutrition*, 76, 1207–13.

Rossi, Peter E., Greg M. Allenby, and Robert McCulloch (2005), *Bayesian Statistics and Marketing*, Hoboken, NJ: Wiley.

Russo, J. Edward, Richard Staelin, Catherine A. Nolan, Gary J. Russell, and Barbara L. Metcalf (1986), "Nutrition Information in the Supermarket," *Journal of Consumer Research*, 13, 48–70.

Schwartz, Jaime and Carol Byrd-Bredbenner (2006), "Portion Distortion: Typical Portion Sizes Selected by Young Adults," *Journal of the American Dietetic Association*, 106 (9), 1412–18.

Shapiro, Eden (1993), "Portions and Packages Grow Bigger and Bigger," *Wall Street Journal* (October 12).

Simonson, Itamar (1989), "Choice Based on Reasons: The Case of Attraction and Compromise Effects," *Journal of Consumer Research*, 16 (September), 158–74.

Simonson, Itamar and Amos Tversky (1992), "Choice in Context: Tradeoff Contrast and Extremeness Aversion," *Journal of Marketing Research*, 29 (August), 281–95.

Sobal, Jeffrey and Brian Wansink (2007), "Kitchenscapes, Tablescapes, Platescapes, and Foodscapes," *Environment and Behavior*, 39 (1), 124–42.

Train, Kenneth E. (2003), *Discrete Choice Methods with Simulation*, Cambridge: Cambridge University Press.

Wansink, Brian (1996), "Can Package Size Accelerate Usage Volume?" *Journal of Marketing*, 60 (3), 1–14.

——— (2004), "Environmental Factors That Unknowingly Influence the Consumption and Intake of Consumers," *Annual Review of Nutrition*, 24 (1), 455–79.

——— (2006), *Mindless Eating: Why We Eat More than We Think*, New York: Bantam-Dell.

Wansink, Brian and Junyong Kim (2005), "Bad Popcorn in Big Buckets: Portion Size Can Influence Intake as Much as Taste," *Journal of Nutrition Education and Behavior*, 37 (5), 242–45.

Wansink, Brian, James E. Painter, and Jill North (2005), "Bottomless Bowls: Why Visual Cues of Portion Size May Influence Intake," *Obesity Research*, 93–100.

Wansink, Brian and SeaBum Park (2001), "At the Movies: How External Cues and Perceived Taste Impact Consumption Volume," *Food Quality and Preference*, 12 (1), 69–74.

Wernerfelt, Birger (1995), "A Rational Reconstruction of the Compromise Effect: Using Market Data to Infer Utilities," *Journal of Consumer Research*, 21 (4), 627–33.

World Health Organization (2003), "Obesity and Overweight," http://www.who.int/hpr/NPH/docs/gs_obesity.pdf.

Yehling, Barbara A. and Sheryl A. Marcouiller (2005), "Prominence of Calories: Effect on Consumer Awareness and Consumption Choices," letter from Krafts Food International to the Federal Drug Administration in reference to Docket No. 2004N-0463 Food Labeling; Prominence of Calories Advance Notice of Proposed Rulemaking 70, Federal Regulation 17008 (April 4, 2005), Rockville, MD: letter dated June 20, 2005, http://www.fda.gov/OHRMS/DOCKETS/dockets/04n0463/04N-0463_emc-000304-02.pdf.

Young, Lisa R. and Marion Nestle (2002), "The Contribution of Expanding Portions Sizes to the US Obesity Epidemic," *American Journal of Public Health*, 92 (2), 246–49.