Using Extremeness Aversion to Fight Obesity:

Policy Implications of Context Dependent Demand

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Obesity is now a global problem. Within the U.S., the rise in obesity has been largely driven by the increase in caloric consumption. Suggested solutions for decreasing consumption have included information provision and taxation on fast food. We investigate a third option that takes advantage of the behavioral regularity where consumers tend to avoid purchasing the smallest or largest size of a portfolio of options. We do so in the context of soft drinks purchased at fast food restaurants. Using a virtual shopping experiment, we estimate for each member of our national sample of adults, their value for drink size, price, and extremeness aversion. We then use these estimates in policy simulations to identify options that are most likely to reduce consumption with limited reduction in retailer profits.

The average American is 24 pounds heavier now than in 1960 (Jacobson and McLay 2006). Over this same time period, the proportion of adults classified as overweight has grown from 44% to 66%[1] and the subset considered clinically obese has more than doubled from 13% to 32% of the population[2] (Flegal et al. 2002; Ogden et al. 2006). Like smoking, obesity has social as well as personal costs. The estimated healthcare cost in the U.S. associated with overweight and obesity is well over $100 billion[3] (DHHS 2001; Finkelstein, Fiebelkorn, and Wang 2003). Nearly half of this expense is borne by government healthcare programs (Medicaid and Medicare) while much of the remainder is met by health insurance premiums (Finkelstein et al. 2003). Because the cost is spread over all tax payers and insurance premium holders, obesity imposes negative externalities on much of society.

Obesity is not unique to American consumers. For example in Canada, 59% of the population is overweight and 23% is obese (Tjepkema 2005). In England over the last 25 years, obesity has tripled (NHS 2005). Even France, long renowned for its thinness, has doubled its obesity levels in just a decade (Rosenthall 2005). According to the World Heath Organization (2003), an estimated one billion adults are overweight worldwide of whom 300 million are classified as clinically obese.

Weight gain generally comes from an increase in consumption or a decrease in activity levels (exercise).[4] Despite the popular belief that exercise and activity levels have declined over the past several decades in the U.S., these levels have remained relatively flat (CDC 2001; CDC 2006a; Cutler, Glaeser, and Shapiro 2003; Kruger, Ham, and Kohl 2005). On the other hand, the

[1] As defined as the Body Mass Index [BMI] > 25 kg/m^2
[2] As defined as the BMI > 30 kg/m^2
[3] The estimated cost in 1998 was $78.5B, inflation adjusted, $104.4B in 2005 (Finkelstein et al. 2003). Alternatively, an inflation adjusted estimate of $129 billion for 2004 is based on an estimate of $117 billion in year 2000 dollars (DHHS 2001) calculated from the Consumer Price Index.
[4] There are a few exceptions: illnesses or the drugs to treat certain illnesses, may lead to obesity or weight gain. These may include Cushing's disease, polycystic ovary syndrome, Bardet-Biedl syndrome and Prader-Willi syndrome. Drugs such as steroids and some antidepressants may also cause weight gain (CDC 2006b).

National Health and Nutrition Examination Survey shows that the average American now consumes 2,725 calories per day, an 18% increase from four decades ago (Popkin and Nielsen 2003). Americans are eating more and this increase in caloric consumption can be directly tied to the observed rise in obesity (Carangelo 1995; Cutler et al. 2003; Young and Nestle 2002).

As might be expected the increase in consumption has paralleled an increase in 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) and cheeseburgers (24%), but from french fries (57%) and sweetened beverages (62%) (Nielsen and Popkin 2003). The question then becomes, what is driving these increases in portion sizes? Is it because consumers desire these larger portion sizes, and thus, the increase in portion sizes reflects the industry's response to this desire? Is it because the effective price of these food types relative to other foods has decreased over the last four decades, and thus, consumers are "sliding down the demand curve?" Or is it because purchase behavior has been modified in response to exogenous market factors that are not associated with the consumer's innate desire for the specific quantity of food?

Insert table 1 about here

One of the goals of this paper it to provide new insights that help answer these questions. We start by looking at the changes in relative prices. As seen in table 1, over the period of 1966 to 1987, the relative price of foods consumed away from home, which includes fast food, has increased by 9.1% while foods consumed at home have experienced a 7.2% decline (Charlet and Hennebery 2004). Also sugar and sweetener prices have increased by 24.7% which could partially explain why prices for non-alcoholic beverages (including soft drinks) have increased by 42%.

These data are opposite of what would be expected if relative price differences were the only explanation for the increase in consumption. This leads us to focus on an alternative explanation – the portfolio of sizes made available by the retailer and the effect this portfolio has on consumer purchase behavior. We center our attention on soft drinks for two reasons. First, as already noted, soft drink consumption has increased dramatically over the last four decades. Second, non-diet soft drinks, which represent 63% of all soft drinks sold (Freedonia Group 2005), provide approximately 11 calories for every fluid ounce consumed. For example increasing a person's consumption from a 21oz drink to the next largest 32oz drink, increases the caloric intake of this consumer by 120 calories. If this increase in consumption was to occur daily, the individual would gain eight pounds within a year, all else equal.

Conceptually our work relies on the well-known compromise effect and tendency to avoid extreme options (Simonson 1989; Simonson and Tversky 1992). Our basic premise is that consumers' purchases are altered by the portfolio of drink sizes made available. We will provide evidence that this malleability of behavior has led profit-maximizing fast food outlets to gradually drop from their portfolio of available drink sizes the smaller drink sizes and add larger drink sizes, ultimately leading to an increase in caloric consumption.

We test our premise via three experiments. The first asks participants to make both purchases in a simulated shopping environment as well as in an actual fast food context. Using a within-subject design we compare these two different experiences to assess the external validity of the more highly controlled, but still quite realistic, simulated shopping experience. In studies 2 and 3 we administer this simulated shopping task to a) a national sample of adults and b) a more homogenous sample of students who frequent a local fast food restaurant. We use their observed purchase behavior to estimate each consumer's value (utility) for a particular drink size (quantity) and his or her disutility for price and the two extreme alternatives. We demonstrate that the particular size that a consumer chooses is not only based on a preference for that size drink and its price, but also where the drink size is located on the quantity continuum in the portfolio. We use these estimated utility functions to derive the demand for soft drinks. This allows us to conduct a number of policy simulations aimed at reducing caloric consumption associated with soft drinks sold at fast food outlets.

Our research extends three different research streams. The first is the empirical research that demonstrates behavior compatible with the compromise effect (Chernev 2005; Dhar, Nowlis, and Sherman 2000; Drolet, Simonson, and Tversky 2000; Hamilton 2003; Kivetz, Netzer, and Srinivasan 2004; Prelec, Wernerfelt, and Zettelmeyer 1997; Simonson 1989; Simonson and Tversky 1992). These demonstrations use market share data (i.e. aggregate data) and a between-subject design to show that market share of an option increases when it no longer is an extreme option. We augment this evidence using within-subject experiments. This allows us to obtain a more nuanced view of switching behavior by testing for any systematic changes in the individual's purchase behavior related to the different drink choice options. Our second extension is methodological and builds on the work of Kivetz, Netzer, and Srinivasan (2004). They develop a series of extremeness aversion models, each of which has a global population parameter for a given product attribute, i.e. their models assume the same effect for all consumers. We propose and estimate an individual level utility function. These individual utility functions allow us to model demand as a function of price and the portfolio of drink sizes made available. We use these derived demand functions to estimate the impact of different policies aimed at reducing caloric consumption of soft drinks. Finally, we supplement the health literature by providing another explanation for why drink portion sizes might have increased over the last few decades.

RELEVANT LITERATURE

The underlying premise linking this research to the obesity problem depends on four well-supported behavioral premises.[5] First, consumers have little knowledge of their caloric consumption. 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 these meals contained about 700 to 800 calories, about half of the actual amount associated with the meal. Similarly in another set of four studies designed with dieticians, Chandon and Wansink (2007) demonstrate that people become even more likely to underestimate calories as the portion sizes increase.

Second, providing consumers with 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. For example, Russo et al. (1986) found minimal changes in grocery shopping behavior in a large field study that displayed nutritional and caloric information. Similarly, among consumers not concerned about nutrition, Moorman (1996) found that the introduction of new nutritional labeling regulations had little impact on purchase habits. In fact there is even some evidence that labeling may actually promote consumption because it gives the impression

[5] Although the major thrust of this paper is to further validate the fourth premise, we use our three studies to provide additional evidence supporting the last three premises.

that healthier foods can be consumed in greater quantities (Bolton, Cohen, and Bloom 2006; Chandon and Wansink 2006; Wansink and Chandon 2006). Although not the primary goal of this research we, too, look at the effects of providing caloric information. We find providing such information does not significantly alter the drink size choice. Taken together these findings attest to the difficulty of using cognitive and motivational information strategies against obesity.

Our third premise states that consumers have a tendency to eat what is put in front of them. We point to the numerous research studies that show children and adults tend to eat more when given larger portion sizes (Fisher, Rolls, and Birch 2001, 2003; Kral, Roe, and Rolls 2004; Kral et al. 2002; Sobal and Wansink 2007; Rolls, Engell, and Birch 2000; Nisbett 1968; Rolls, Morris and Roe 2002; Wansink 2004, 2006; Wansink, Painter, and North 2005). For example, Levitsky and Youn (2004) report that young adults, served larger portions from one week to the next increase their consumption the next week by as much as 40%. Wansink (1996) demonstrates that consumers given larger containers tend to use a larger amount of the item and Geier, Rozin and Doros (2006) observe people consuming substantially more M&M's when they self-serve themselves using a larger spoon compared to a smaller spoon. DiMeglio and Mattes (2000) point out that drinks pose an even greater risk of over-consumption, since beverages normally do not satiate the consumer's appetite as much as solid foods. We augment these results by showing 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 context of the situation. Bettman, Luce and Payne (1998) demonstrate through a vast review of the literature that choice is largely based on contextual cues rather than the result of preset ordered preferences. People have neither the capacity nor the desire to mentally store preferences related to every possible purchase. Thus consumers often construct various heuristics and strategies to facilitate choice, making the decision highly contextual and dependant on the situation at hand. Their review describes how choice is impacted by numerous contextual factors such as time pressures, number of options, missing information, information format and the options in the choice set. Our main interest is in this latter factor, in particular that consumers tend to avoid the extreme option. We soon present evidence that this general effect has substantial implications for the purchase of soft drinks in a fast food environment.

METHODOLOGY

OVERVIEW

We investigate 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 a person's purchase and consumption behavior using a national sample of adult consumers. 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 different restaurants carry different portfolios of drink sizes. Thus a drink size is sometimes the smallest (largest) and other times it is a compromise option. In Study 1 we assess the external validity of this approach by asking a sample of young adults to complete the same road trip experience and then about a week later to come to a central location to purchase and consume a fast food meal from a local McDonald's restaurant. The menu used to purchase the meal was identical to one of the menus they saw during the simulated road trip. We use their simulated and actual purchase behavior to determine their consistency (reliability) across the two experiences. In addition we use the consumption information to determine the correspondence between purchase behavior and actual consumption.

The second study uses a national sample of adults who have indicated they eat meals at fast food restaurants. We use this sample to determine if 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 12oz, a 16oz, a 21oz and a 32oz drink, and the second is similar except that the 12oz drink is not available. If some consumers are averse to buying the smallest size we should expect some participants who bought a 16oz drink in a condition where a 12oz drink was available to purchase the 21oz drink when the 12oz drink is dropped, since the 16oz drink is now the smallest sized drink available.

We use our within-subject design and the results from this national sample to develop and estimate structural models of consumer choice. These models enable us to run a series of policy simulations aimed at determining the impact of specific policy actions on caloric consumption. To foreshadow some of results from the studies, we find consumers tend to shy away from the smallest and largest sized options. Consequently dropping a 12oz drink not only results in most 12oz drinkers purchasing a 16oz drink, but it also results in many of the 16oz drinkers moving up to a 21oz drink. Likewise dropping a 44oz drink results in some 32oz drinkers decreasing their purchase amount since it is now the largest drink available. We also find a strong correspondence between what participants purchase in the simulated shopping task and what they actually purchase when given the opportunity to buy a meal at fast food restaurant. Moreover, they consume most of what they purchase and this percentage is not impacted by portion size. Finally, we find it is possible to reduce calorie consumption without imposing stiff taxes on calories. This is accomplished by setting CAFÉ-like standards where fast food outlets are free to modify prices and drink assortments in order to reduce total consumption of calories associated with soft drinks. Such a solution imposes fewer market restrictions and thus imposes fewer costs on the consumer and the retailer.

Study 1—The External Validity Study

Participants are college students who are asked to complete a three part study where one part involves purchasing and consuming a lunch meal at McDonald's. The first two parts of the study are completed online and are almost identical to the tasks preformed in the next two studies. In the first part of the study, participants go on the simulated road trip. In the second part participants complete a conjoint task in which they see ten different sets of drinks. Each set is composed of either three or four drink sizes as well as a no drink option. Participants are asked to select their preferred drink size for each set. We refer to the first part as the "road trip" and the second as the "conjoint" task.

Before the road trip begins, participants view pictures of the potential drink sizes (12oz, 16oz, 21oz, 32oz, and 44oz) as well as side order sizes and many of the entrees available at the restaurants visited during the road trip (for example, see figure A1 in the appendix). The idea is to familiarize them with the actual drink sizes without focusing their attention on any one item. Participants then start their 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 are given a brief description characterizing what is happening along the trip. This description provides some information about the restaurant, and indicates the reason for choosing a particular restaurant. Also to limit prior experience with a restaurant in determining soft drink size, none of the restaurants in the study are associated with a major fast food chain, but are still real establishments (see figure A2 in the appendix for an example). Participants are then presented with a menu for the restaurant and asked to choose an entrée, a side order, and a drink (see figure A3 for an example). After making their meal choice, they are provided with the total meal price.

Participants make nine different stops during the road trip part of the experiment with the context changing at each stop. Both the assignment of assortment conditions and the order of the nine restaurants vary across participants. Each restaurant had a particular "type" or theme in terms of the entrées. These include beef (hamburgers), chicken, pasta, pizza, fish, and Mexican. Likewise each restaurant carries a specific parent brand of drinks (Coke brand versus Pepsi brand)[6]. Prices for each of the soft drink and french fry sizes are held fixed and Study 1 represent the prices posted at the local McDonald's. Participants are 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 purchase at least one item on every stop on their virtual trip.

The main manipulation in this study (and the other two studies) is the portfolio of drink sizes available. In Study 1 participants see three of the five different drink menu conditions used in the main study. One drink menu condition contains three drink sizes, 16, 21, and 32 ounces. We refer to this condition as the *core condition*, since all of these three drink conditions contain these three drinks. A second menu condition (the *high condition*) augments these three drink sizes with a 44oz drink. The third drops the 44oz but adds a 12oz drink. We refer to this condition as the *low condition*.

[6] In a pretest we find no systematic effect of restaurant name or type, order of the trip, or parent brand of drinks on purchase behavior. We do not discuss these experience attributes again.

A second key component of this road trip is that participants see each of these three conditions three times during the road trip. This enables us to determine how reliable (consistent) participants are in terms of buying the same size drink each time, conditional on a given portfolio of drinks being available. We use this estimate of consistency as our benchmark when assessing the correspondence between the person's road trip and actual purchase behavior.

The second part of this study is a conjoint task where participants are shown 10 sets of drinks where the sets vary in prices and available drinks. We do not use the information obtained from this conjoint task in Study 1 and thus describe the task in more detail when discussing Study 2.

The third part of this study takes place about a week after the participants complete the two online tasks. Participants come to a room in the student union at lunch time with the understanding that they will be filling out a brief survey. In addition they are told they might have some spare time and thus they should bring along some study material (finals were scheduled for the next week). Upon arrival, they are paid $10 for completing the first two parts of the study. They are then given an additional $7.50 (or $6.00) and told they may use this money to purchase their lunch which they are to eat while they read or study. The ordering is accomplished by giving them a menu especially designed for the study. This menu is identical to one of the menus used in the virtual shopping trip and includes six of the most popular entrees sold at the local McDonald's, three sizes of fries and one of the three drink size conditions, where the determination of which drink condition is used is random. After placing their order, participants pay for their meal from the money allocated for this purpose. Participants are then asked to go into a quiet room where they can study and ultimately fill out the brief survey. Soon after entering this room their meal is delivered to them. Twenty five minutes later they are asked to fill out the brief survey about their study habits and an open-ended question asking them their beliefs about the purpose of the study. After completing this survey they are excused and told to leave the contents of the meal at the table where they were sitting. Each person's meal remnants is later collected and weighed to determine the percent of the meal the person consumed.

Study 1 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 entrees in combination with a side order of fries meant that buying any drink exceeding the $6 limit. It appears that many of the participants treated this $6 amount (instead of the total compensation of $16) as a constraint on how much they could order. As a consequence we observed a larger proportion of participants than would have been predicted from their virtual road trip behavior (where there was no explicit budget constraint) not ordering a drink. In order to make the two experiences more comparable, we altered our procedures for the last 65% 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."

Correspondence between Simulated and Actual Purchase Behavior

We conduct two analyses to determine the correspondence between actual and simulated purchase behavior. In the first we look to see if, on average, participants' drink purchase quantity differs depending on whether they actually purchased the drink or they purchased it on the virtual road trip. We pair up the actual purchase quantity with the three simulated road trip purchase quantities made under the same drink conditions. We form three differences by subtracting the quantity actually purchased from each of these simulated purchases. We regress these differences against a constant and a dummy to indicate if the person was given $6 or $7.50.

The intercept, which represents the average quantity difference between the three virtual road trip choices and the actual choice, was not significantly different from zero (p=.82) although the budget constraint dummy was highly significant (p<.01) and positive (.277 ounces), reinforcing our observation that the $6 limit causes some participants not to purchase a drink. Howevero the insignificant intercept leads us to conclude that once we took away the budget constraint, participants neither increased nor decreased their actual purchase quantity compared to their simulated purchase quantities, i.e. simulated and the actual purchase quantities are, on average, equal.

Note that our proposed within-subject analysis of switching behavior is predicated on the premise that participants display consistent patterns when conditions do not change and thus any switching behavior can be attributed to the changes in drink format. We test this premise by comparing, within a given drink size condition, the chosen drink size on the first occasion with that chosen on the second occasion and the second with the third. We form two binary variables where 1 indicates the person purchases the same drink size on the two occasions and 0 otherwise. This yields six measures across the three drink size conditions of the person's consistency within the virtual road trip. In addition we compare the identity of the drink size purchased the last (third) time the person saw the relevant menu during the simulated experience with the identity of the actual drink size purchased. We use this last measure to determine if the consistency changes either because of the long time lapse—and thus a different context (e.g. time since last meal, different mood, etc.) or because the task is somewhat different. We regress these seven differences per participant against the drink condition, whether the comparison was the first, second or third (i.e. between the third virtual road trip and the purchase occasion) and a dummy to indicate if the purchase occasion was associated with the budget constraint. The results are shown in table 2 and indicate that participants in the *core* condition had an average consistency of 69% between the first and second visit and this increased by 6% between the second and third visit. When a 42oz is added as in the *high* condition, the average consistency the first time is 70%. However when a 12oz is added to the choice sent as in the *low* condition, the consistency increases to approximately 78% between the first and second purchases and is 84% between the second and third trips. More relevant for our purposes we find the consistency decreased by about 10% when participants purchase a drink one week later as long as there is no budget constraint.[7] Although this indicates a reduction in consistency compared to the simulated purchases, we still take this as strong evidence that the person's simulated purchase behavior is highly predictive of their actual purchase behavior.

Insert table 2 about here

Finally, since we are ultimately interested in caloric consumption, we analyze the correspondence between what the person purchases and what the person consumes. We do this separately for entrees, side orders and drinks. Specifically we regress the calories consumed against the calories purchased for anyone who purchases the item of interest, controlling for the drink condition. We find no effect of drink condition on calories consumed for entrees and side orders. However, we find a highly significant impact of the amount purchased on the amount consumed. Specifically we note that participants consume 93% of their entrée and 93% of their size order ($p<.0001$).[8] For soft drinks we find the percent consumed is 83% overall. Moreover

[7] When we added the budget constraint, we notice a further decrease of almost 10%.
[8] We note that the percentage of consumption for the side order differed significantly depending on the size of the purchase. Thus purchasers of the smallest size of fries only consumed 87% compared to 94% for the two larger sizes.

this percentage is not a function of whether the person bought a diet or non-diet drink.[9] We take this as strong evidence that we can use purchase data to infer actual consumption.

In summary we find strong evidence that the virtual road trip survey yields externally 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 the person's selections of a particular drink size strongly correspond to the person's actual drink choice. Finally this choice maps into the person's consumption of the food purchased. These findings support our contention that we can use our virtual road trip methodology to determine the purchase behavior (and thus the consumption behavior) of a broader set of participants. This is important since we use these data to estimate the participants' utility functions and make general assertions concerning how different policy statement should affect consumers' consumption patterns.

Study 2—National Sample

Participants for this study are 304 adults who indicated that they frequent fast food restaurants at least once a month. These participants are compensated by an independent market research firm that maintains a panel of participants who periodically participate in different research studies and are compensated for points that can be exchanged for gifts. The participants live throughout the United States and as can be seen from table 3 closely approximated the United States demographics on gender, ethnicity, and race.

Insert table 3 about here

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[9] When we allowed for different percent consumption by portion size we found purchasers of the two largest sized drinks consumed less, although none of the percentages for any drink size was statistically different from the other sizes. We attribute this (non-significant) decrease in percent consumption, in part, to the fact that participants were not allowed to take their remaining drink contents with them. Casual empiricism leads us to believe that the majority of those who asked to bring their drinks with them were those who ordered the larger sizes.

The study uses the two part, online "virtual" shopping experience previously described in Study 1, with a few minor changes. As before, we manipulate the availability of specific drink sizes, the only difference being that they see five different drink size conditions. In addition to the *core, low* and *high* conditions they also see a *full* condition that contains the core drinks along with the 12oz and the 44oz sizes, and a missing 21oz condition (*no 21oz*) which drops the 21oz from the *full* condition. A summary of the conditions is in table 4.

Insert table 4 about here

Each drink condition is fully crossed with the restaurant and visit order variables. Thus across respondents, each drink size condition is associated with each restaurant and each visit order (i.e., first, second, third, etc). The order the participants experience each of the drink size conditions varies across subjects. Consequently, drink size is a within-subject manipulation, while restaurant, parent brand of drink, and stimulus order are between-subject manipulations.

Two other features of this design merit comment. First, as in Study 1, the ninth trip provides calorie information in the menu. This trip was crossed with drink condition. We test to see if 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. Second, although prices are fixed for 8 of the 9 trips, they are decreased by about 20 cents per drink size for one replication of the *high* condition. We use this trip to determine if our participants respond to lower prices.[10] These two design features imply that we only replicate two drink conditions, the *core* and *full* conditions in the road trip portion of Study 2.

[10] As might be expected we find small upward shifts in purchase quantity, mainly from the 21oz drink to the 32oz drink in this lower price condition. We take this as evidence that our participants took prices into account when making their simulated purchases.

After completing the road trip, participants are presented with 10 "standard" conjoint choice tasks to more thoroughly examine the potential effect of price on the choice of drink size, where each alternative is described in terms of portion size and price. The participants are asked to choose between either three or four sizes of their favorite soft drink along with the no choice option. As shown in table 5 the specific choice sets and prices are chosen to vary both the price differential between sizes and the absolute prices charged for any given size. Prices vary between 35 and 45 cents per size and the price differential between a size and the next highest size varies from 40 cents to -14 cents.[11]

Insert table 5 about here

Time to complete these two tasks took between 6 and 45 minutes with the average time being 11.8 minutes.

National Sample Results

Since we are able to determine an individual's behavior for each of the four size conditions, it is possible to obtain a more nuanced view of switching behavior than can be obtained from analyzing aggregate market shares changes as a function of the available drink sizes. 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 12oz drink. If there is no context effect present, standard economic reasoning predicts that the only systematic changes in purchase behavior would come from

[11] We use the one negative differential to see if any participants select a smaller sized drink even though it cost more that the next highest level drink. This provided a (weak) test of the standard assumption that people prefer more to less all else equal. Empirically we find 6% of our sample actually selected this (dominated) drink size. Such behavior is either "irrational" or indicates an ideal point model for some consumers.

customers who chose the 12oz when it is available, since these 12oz choice consumers are forced to make a different choice. The customers either choose another size or not purchase a drink at all. In our sample there are 111 participants who purchase a 12oz drink when the low set is available.[12] When the 12oz drink is not available only 4% of these 111 participants decide not to buy a drink, while 94% purchase the next largest drink (i.e. the 16oz) and the remaining 2% purchase one of the two larger sizes. Such behavior is compatible with rational value maximization and the concept that consumers have increasing value for more soft drink all else equal.[13]

To investigate extremeness aversion we look at the 102 people who chose the 16oz size in the *low* condition and examine what they purchased when they were in the *core* condition, since in this condition the 16oz drink size is the smallest option available. Consistent with our Study 1 results on the reliability of purchase behavior, we find 73% of these consumers repeated their purchase of the 16oz drink. However, 23% increased their consumption by shifting to the 21oz drink. This latter behavior is not compatible with value maximization, since their initial choice was still available. However, it is compatible with extremeness aversion.

Although this observed switching pattern is compatible with extremeness aversion, it 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 partition changes in purchase behavior into that associated with random (unreliable) behavior and that associated with behavior due to contextual

[12] As an aside, we find it interesting that 35% of our sample indicated that they would buy a 12oz drink if available even though none of the major fast food outlets indicate on their menu's that such a size is available other than with a kiddy meal.

[13] One might speculate that consumers have a tendency to move up when their preferred option is not available, However we did not observe this when we removed the 21oz drink from the portfolio. In that case 49% increased their purchase quantity and the remaining percentage decreased their purchase quantity.

effects. We do this as follows. For each individual, we calculate the differences in an individual's purchase quantity between focal restaurant trips and base restaurant trips where the focal restaurant represents a condition where a drink size was added or dropped relative to the base restaurant condition. For example if we want to determine the effect of dropping the 12oz drink we look at the purchase quantity of an individual in the *high* set (the focal restaurant trip) and subtract out the quantity purchased in the *full* set (the base restaurant trip). Similar types of comparisons allow us to assess the impact of adding the 12oz to the *core* set, adding the 44oz to the *core* set and dropping the 44oz from the *full* set. We augment these differences with differences in purchase quantity when the conditions were held fixed, i.e. *core* set and the *full* set. These latter two differences allow us to determine for each participant their reliability in purchasing the same drink size when given the identical portfolio of drinks. Thus for each individual we have six observations, two based on the purchase records for the same menus and four based on the purchase records for varying menus.

We regress these six differences for each individual against dummy variables for the drink sized purchased in the base trip and these dummies interacted with the condition found in the focal restaurant. The results of this regression are shown in table 6. We first look at the main effect variables associated with the drink size purchased in the base restaurant trip. We see a strong regression to the mean, indicating that all else equal participants tend to buy a larger drink if they initially purchased no drink, a 12oz drink or a 16oz drink. Likewise they tended to buy a smaller drink if they initially purchased a 21oz, 32oz or 44oz drink. We next look at the estimates associated with situations where the 12oz drink was either dropped or added. In the former situation the 16oz drink now becomes the smallest drink available. Consequently, extremeness aversions would predict that some participants who initially purchased the 16oz drink would move to the next size, thus increasing the average consumption. This is what we observe, with the average consumption increasing by 1.33 ounces (p<.025). Conversely, adding a 12oz drink makes the 16oz drink no longer the smallest drink available and thus more attractive to anyone who is averse to the smallest size. Here we note participants who initially bought the 21oz drink decreasing their purchase quantity by 1.49 ounces (p<.06). Analogous findings are seen when we look at adding and dropping the 44oz drink. Dropping the 44oz drink should make the 32oz drink less attractive to consumers who initially purchase this size if these consumers are averse to purchasing the largest drink available. This is what we observe with the average consumption for the initial 32oz drinker decreasing by 2.58 ounces (p<.03), even after controlling for a person's tendency to regress toward the mean. Adding the 44oz should make the 32oz drink more attractive to the 21oz 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).[14]

Insert table 6 about here

In summary these data are very compatible with the premise that consumers alter their purchase quantity in part to reflect the identity of the smallest and largest options. Although this effect has been shown before using aggregate data, we believe this finding should be of great interest for two reasons. First, in our setting participants are very familiar with all the alternatives in the possible choice sets. Thus the compromise effect appears to be very subtle and almost

[14] The above analysis made no distinction between diet and non-diet 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 conditions (p<.72).

"unconscious." Second, our data provides a more detailed view of the identity of consumers who are modifying their choice behavior.

We next use this individual level data to develop a model of individual drink size choice which 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

We start with the work of Kivetz, Netzer, and Srinivasan (2004) that postulates four possible models designed to capture consumers' extremeness aversion. These models are predicated on the assumption that the preferences for a desired attribute increase (decrease) with the level of the attribute (i.e. each attribute is a vector attribute). The researchers estimate these different models by asking participants to complete a conjoint task similar to the one we used in our studies. They use these data to first estimate individual level utility models and then in a second stage, they estimate one population level parameter per attribute that, in effect, reduced the individual's utility of the attributes near the extremes. More technically, they made each person's utility function more concave, thereby increasing the utility of the middle attribute levels 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. Specifically, we define individual *i*'s utility for drink size *j* in choice set *k* to be defined as

$$U_{ij|k} = V_{ij} + \lambda_i \bullet \mathrm{min}_{jk} + \gamma_i \bullet \mathrm{max}_{jk} + \tau_i p_j + \varepsilon_{ijk} \quad (1)$$

where V_{ij} is the individual's valuation for drink size j, min_{jk} and max_{jk} are dummy coded variables indicating whether size j is the minimum or maximum in the 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 Kitvetz 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 also assume that consumers value a lower price over a higher price. These assumptions are often used in economic modeling (i.e. Ratchford and Gupta 1990) and imply that demand increases as quantity increases, and demand decreases as price increases. Finally, we assume 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.

We estimate the parameters (see appendix B for details) using Hierarchical Bayes (Rossi, Allenby, and McCulloch 2005; Train 2003). This technique has a number of side benefits. First, instead of estimating a contextual effect that applies to everyone, it provides a posterior distribution for each parameter for each individual. These posterior distributions are based not only on the individual's choices but also on the aggregate distribution of choices across the population. Additionally, this technique does not require the number of choice alternatives to be constant across all choice opportunities; thus, the road trip choice data can be combined with the conjoint paired comparison data in order to estimate the utility function.

Table 7 reports the population mean estimates, i.e. the average of each respondent's mean value, along with the standard deviation of these means across the sample population. These average estimates and the variance of estimates across the population indicate that many our participants have a negative evaluation for extreme options. Interestingly we find the average aversion to the smallest size is less that for the largest size, i.e. λ is slightly positive while γ is estimated to be -2.42. Just as important the standard deviations for each of these parameter indicate considerable heterogeneity in the utility for the drink sizes as well as the participants' (dis)utility for the smallest and largest size drink.

Insert table 7 about here

Although these population averages are of some interest, our primary interest is 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 8 provides the mean estimates for participant #92. This individual is averse to both the smallest (-1.60) and largest extreme (-.84) 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.

Insert table 8 about here

Note that drink sizes are never 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. In table 9 we show participant #92's estimated utility in two different contexts. In the first this participant sees drink sizes varying from 12oz to 42oz. In the second, the 12oz 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 16oz drink when the 12oz drink is available, but switch to a 21oz drink when the 12oz drink is removed. 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.

Insert table 9 about here

POLICY EXPERIMENTS

These individual level parameter estimates allow us to assess policies that have the likelihood of reducing consumers' soft drink volume consumption and ultimately reducing their weight. One might claim that such a reduction would have only minimal impact on helping address the current obesity problem. However, changing one aspect of a consumer's behavior can have measurable impact in the long run (CDC 2006b, Cutler et al. 2003). As noted earlier, switching from a 21oz to a 32oz soft drink will result in a consumer gaining approximately eight pounds a year if this person consumes one non-diet soft drink a day. Take, for instance a 25 year old male of average weight and assume he maintains his activity level over the next five years. If this person were to modify his behavior as described above, he will be overweight before age 30 and obese by 35. Moreover, this seemingly harmless extra 120 calories a day is likely to go unrecognized. It is just a single size increase. Consequently we believe our research not only contributes by providing a better understanding of an interesting consumer choice rule, but it will also allow us to understand a) why firms have increased portion sizes in the quest for profit maximization and b) the impact of possible approaches to addressing consumers' overall health.

We are certainly not the first people interested in curbing soft drink consumption via policy intervention. Medical experts and politicians have suggested 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 three years (Gruber 2001). For example, we note the World Health

Organization proposing tax unhealthy foods, over a dozen U.S. states instituting a soft drink tax with many other states considering doing the same, and the American Medical Association considering lobbying Congress for larger scale taxation on soft drinks (Gruber 2001; Jones 2003; Ritter 2006).

We propose an alternative policy that we believe also has the potential of addressing the issue of soft drink consumption. This approach sets volume targets for firms, but does not say how firms need go about meeting these targets. Thus it is similar to the Corporate Average Fuel Economy (CAFÉ) standard found in the automobile industry. Under CAFÉ, 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 efficient standard. Enactment of CAFÉ in the U.S. has been credited with doubling fuel efficiency between 1975 and 1989.[15] One could imagine a similar standard for the fast food industry where firms would manage to an average drink size purchased. Firms would be free to decide on the portfolio of drink sizes they would like to offer and at what prices they would like to charge given the competition and standard.

We compare the outcome of a CAFÉ-like standard with two different 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 our proposed standard setting approach can reduce consumption up to 14% with minimal financial stress to firms and consumers. We see this as an important objective since a significant criticism of taxation is that it imposes most heavily on low income individuals. Additionally, we give evidence that our standard setting approach should be more acceptable to fast food firms, since as we soon show, it has less impact on the bottom line.

[15]http://nhtsa.gov/cars/rules/CAFE/studies.htm

Before presenting our results, we briefly describe the procedure used in our policy simulations (see Appendix D for more details). We first use the methodology used in Study 2 to obtain utility estimates for a sample of 178 young adults who represent the relevant market for a local fast food restaurant. We then use each individual's estimates to run a series of policy simulations. Each simulation starts with a specific environment (i.e. a set of prices and a portfolio of available drink sizes). We then use these estimates to predict each individual's drink size choice (including the no drink option) 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 (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.[16] We repeat this total process 90 times, each time using a different draw from the posterior distribution of parameter estimates for each individual in our sample, i.e. creating a different possible underlying demand. In effect, 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. From the perspective of the consumer, we assume our sample is representative of the soft drink population facing the local restaurant and that each respondent chooses just one drink size that maximizes the individual's utility. If customers do not purchase a drink, we assume they will choose a cup of water for which there is no charge to the customer. We also assume drink

[16] Implicitly we are assuming the firm has perfect information on consumer demand and sets prices to reflect this demand.

consumption and the cost of the drink do not affect other food purchases. Finally we assume all of our sample purchases a non-diet drink.[17]

From the retailer's perspective, we assume that the outlet only offers standard drink sizes (i.e. 12oz, 16oz, 21oz, 32oz, or 44oz) since these are the standard cup sizes available today from fast food outlets. We 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 reflects the increase in marginal costs associated with the larger size. These costs are listed in table 10 and 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 12oz and 16oz and 16oz and 21oz drinks and a 20 cent increases between the 21oz, 32oz, and 44oz drinks. Second, we assume that the price for the 44oz will be no higher than $1.89 since we currently do not observe prices higher than this in the fast food marketplace. Finally we assume the retailer's goal is to maximize profits and the retailer will choose the portfolio of drinks that yields the highest profits under any given policy. These assumptions mimic the behavior of a profit maximizing firm acting as a partial monopolist, i.e. one facing pricing constraints brought on by competition, internal costs, and possible government policy. We believe these assumptions closely approximate the current fast food environment, but we will later discuss the robustness of our results to different assumptions.

[17] We acknowledge that a substantial proportion (42%) of this sample purchased a diet drink. However, as we showed previously, we find no difference in behavior in terms of the reaction to different drink portfolios between diet and non-diet drinkers. Thus 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 non-diet drinks.

Insert table 10 about here

Table 11 displays for a number of different policy conditions, the average profit per customer, average soft drink consumption levels, and market shares for each drink size for each of the four drink portfolios. We start our discussion by looking at the base case where there are no policy restrictions. Under this (non)- regulatory regime the high condition, i.e. the 16oz - 42oz portfolio of drinks, yields the highest revenue and profit per customer. In contrast, the low drink portfolio that drops the 42oz and adds the 12oz size yields the lowest revenue and profit per customer. This result is consistent with the assertion that fast food outlets, in their quest to maximize profits, have gradually increased portion sizes by dropping the 12oz drink (even though there is considerable demand for this drink size) and adding the 42oz drink (even though there is little demand for this size). Part of reason that we find this increase in profits is due to the fact that most people who initially would have bought the 12oz drink now prefer to buy the next largest size, and thus, pay more for a soft drink rather than not purchase a drink as demonstrated in figure 1. However this is not the only reason. By adding the 42oz drink and dropping the 12oz drink, consumer demand is shifted 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. When a firm changes from the low condition to the high condition portfolio, we estimate 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 next consider three possible policy actions. We compare the implications of each against the base case, the high condition portfolio (16oz-42oz), the portfolio the profit maximizing retailer would chose if there were no government restrictions. Moreover, in order to facilitate comparisons we assume that the policymaker's goal is to establish a policy that leads to a 10% reduction in consumption from this baseline condition.

Consider first the implications of imposing a flat tax on every soft drink purchased. We assume firms can modify their prices conditional on the size of the tax. Thus firms still maximize their profits, but this time under the constraint of the tax. For our sample we find this flat tax would have to be 28 cents per drink if consumption is to be reduced by 10% assuming the retail outlet offers the baseline portfolio of drink sizes. As seen in table 11, 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. Thus the percentage of people who do not buy a soft drink increases from 8% to 19% and the average amount paid, including those consumers who no longer buy a soft 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 16oz-42oz portfolio. Instead it would augment this portfolio by adding a 12oz 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 our baseline condition (16oz-42oz) that assumes no tax.

We next evaluate a graduated tax where the tax is based on ounces of consumption. We again determine the tax needed to yield a 10% reduction from our baseline condition. As before, we assume firms react to this tax 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 11 cent tax for the 12oz drink to a high of a 38 cent tax for the 42oz drink. Since this graduated tax has less impact on the smaller sizes, we find fewer consumers buying no drink (15% compared to 19% for the flat tax).

Moreover, the higher tax on the larger sized drinks pushes consumption toward the lower priced, smaller drinks. Finally we again note that under this taxing policy, the retailer would offer a 12oz drink since profits are highest with the 12oz to 42oz portfolio. As a result the consumption level would be reduced below the 10% objective.

The above two tax policies rely on higher prices to reduce overall demand. As a byproduct, both the flat tax and graduated tax decrease firm profits, reduce the number of customers who buy soft drinks (i.e. are priced out of the market), and increase the average price paid compared to the base case. With this in mind, we next explore a CAFÉ-like standard where firms would be held to an average drink size target to reduce consumption by 10%. As before, we explore what a profit maximizing firm would do in order to meet such a restriction. Thus the firm could increase prices thereby sliding down the demand curve or offer a different portfolio of drink sizes thereby modifying consumer choice. We find that under the baseline portfolio the firm 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 32oz and 42oz drink sizes. As a result almost all the consumers buy a soft drink, the average price is decreased by 45%, and the retail soft drink profits 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 42oz drink from its portfolio and add a 12oz drink, using extremeness aversion to drive down the average size of the drink. Comparing this solution to the two tax policies, we note consumers pay less on average and 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.

DISCUSSION

The overarching goal of this paper is to better understand how policy makers might address the obesity problem by reducing the consumption of soft drinks within the fast food environment. This required us to predict how consumers would respond to changes in offered sizes and prices. We address this task as follows. First we recognize that the behavioral phenomenon of extremeness aversion can impact consumers' choice of a soft drink size when buying from a portfolio of drink sizes in a fast food restaurant environment. We then formulate an individual level utility model that incorporates this phenomenon and conduct an experiment that allows us to estimate each person's value for size, as well as the disutility for higher price and the extreme options. We then use these estimates to illustrate how different policies impact firm profits, prices, and consumption.

Though this research is motivated by the obesity problem, we believe it should appeal to consumer behaviorists in general. Thus up until this work, little has been done experimentally or empirically to investigate the extremeness aversion effect using choice sets that exceed three products. Moreover almost all the modeling and estimation of this behavioral effect had been done at the aggregate level. In contrast, our experiment uses a within-subject design and up to five product choices. This experiment not only provides additional evidence of extremeness aversion, it also enables us to measure the degree to which this aversion is a homogeneous trait found within the population. We find most individuals tend to avoid the two extremes. However, these effects differ across individuals and even within an individual. For example, an individual's aversion to the smallest extreme often differs from his or her aversion to the largest extreme. Thus, this academic research not only allows us to better understand and model these complex individual reactions, but it also allows us to measure the impact of both personal and policy decisions in ways that can be relevant to consumers, government, and firms.

With regards to the policy experiments, we noted that a profit maximizing firm currently finds it best to carry a portfolio of four drinks, a 16oz, a 21oz, a 32oz and a 42oz. This occurs even though approximately 17% of our sample indicated they would choose a 12oz drink at the optimal price levels and only 2% indicated they would purchase the 42oz drink. Our simulation reveals why the retailer seems to be offering a different portfolio of drinks than one might infer from these percentages. First, most consumers who indicate they prefer a 12oz drink will purchase a larger size drink if the 12oz drink is not available. Consequently the outlet does not lose many sales by dropping the smallest size. Second, by adding the 42oz and making the 16oz drink the smallest drink size, the outlet is able to influence the choice of those customers who initially purchased the 16oz and 21oz drinks. Specifically some of the 16oz consumers will move up to the 21oz drink in order to avoid purchasing the smallest drink size and some of the 21oz drink consumers will now find the 32oz drink preferable since it is no longer the largest size drink. In this way the profit-maximizing outlet will increase consumption even though the underlying preferences have not changed.

Our policy simulations also show that if the government imposes either a flat tax or graduated tax, it is optimal for the firm to add a 12oz to its current offering of 16oz through 42oz 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 these tax policies not only cause the firm 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 point out the complex interactions between policy, firm reactions, and consumer behavior as well as emphasizing 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 consumption levels produces the desired volume reduction and the least negative impact on both firm profits and 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), we find setting a standard often is more acceptable to firms since it reduces the need to compete on this dimension.

Though 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 beverage firms' reactions to this inward shift in their demand curve. Standard economic theory predicts 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 effects 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.

Our analyses have other simplifying assumptions that limit our ability to generalize to the U.S population as a whole. First the sample used for the policy simulations was restricted to one local market. However, given the similarity of results across our three samples we believe our results should generalize to most local markets. In addition many of our results (e.g., extremeness aversion, the benefit of CAFE-like systems) are expected to be similar regardless of the distribution of particular utilities. That said, any serious projection to a national or local level policy would require an appropriate sample.

We also note 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 portfolio that contains a very large drink size (e.g. 44oz) makes the standard bundle, which now contains a 21oz drink seem less extreme. More importantly, 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 16oz to 21oz 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 impacted 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[18], but given the research of Wansink and colleagues (1996, Wansink and Kim 2005; Wansink and Park 2001) on the effects of container size and consumption, we expect 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 also note that we assumed firms had perfect knowledge with respect to their underlying demand. One might imagine a scenario where they had no better information than we, as

[18] For our local restaurant, approximately 10% of the customers obtained a refill.

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 11 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 CAFÉ-like standard would require the most information. First firms would need to submit the total number of customers (estimated by, say, the number of entrees sold) as well as the number of drinks sold for each size. Thus the average volume sold could be computed.

Finally, there is the question about whether the effect of extremeness aversion will sustain over time. We believe it does, as shown by the persistent increase in consumption as the size offerings have increased over time for fast food. People adapt to sizes, see others consuming such sizes and soon new sizes becomes 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 A

Figure A1

Description of the stimuli for the road trip study

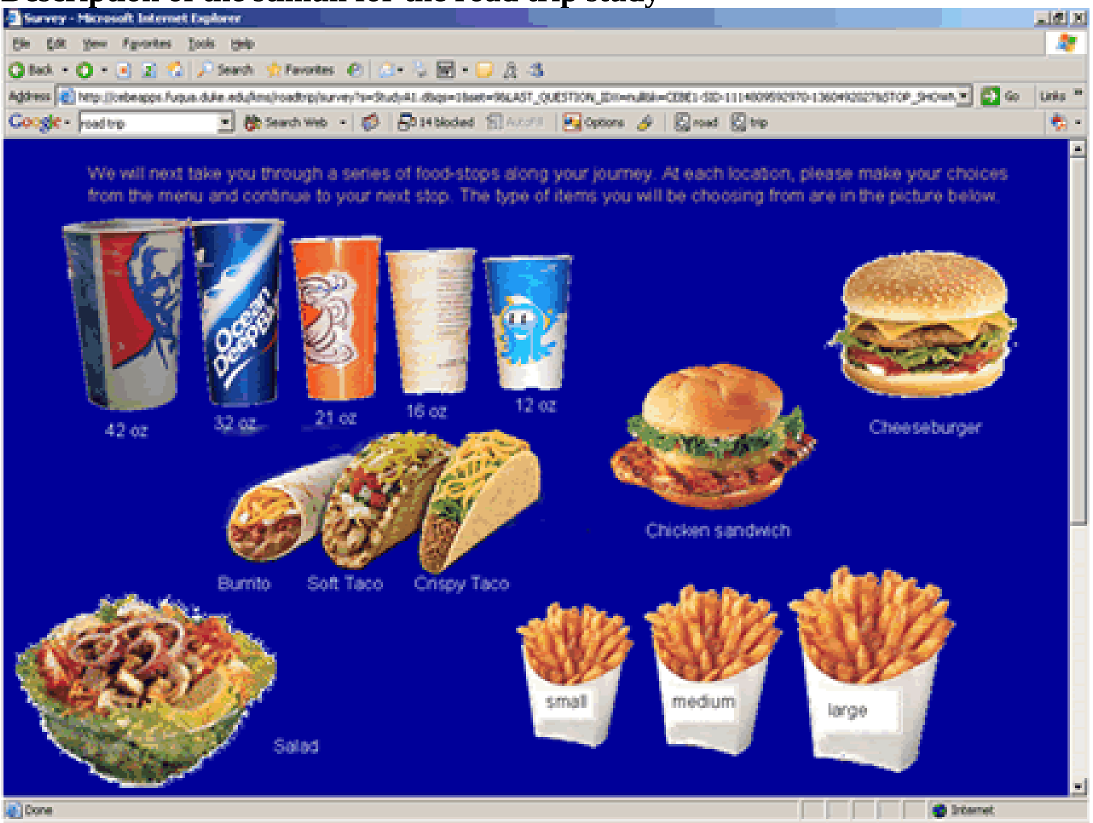


Figure A2

Example of a restaurant and trip scenario

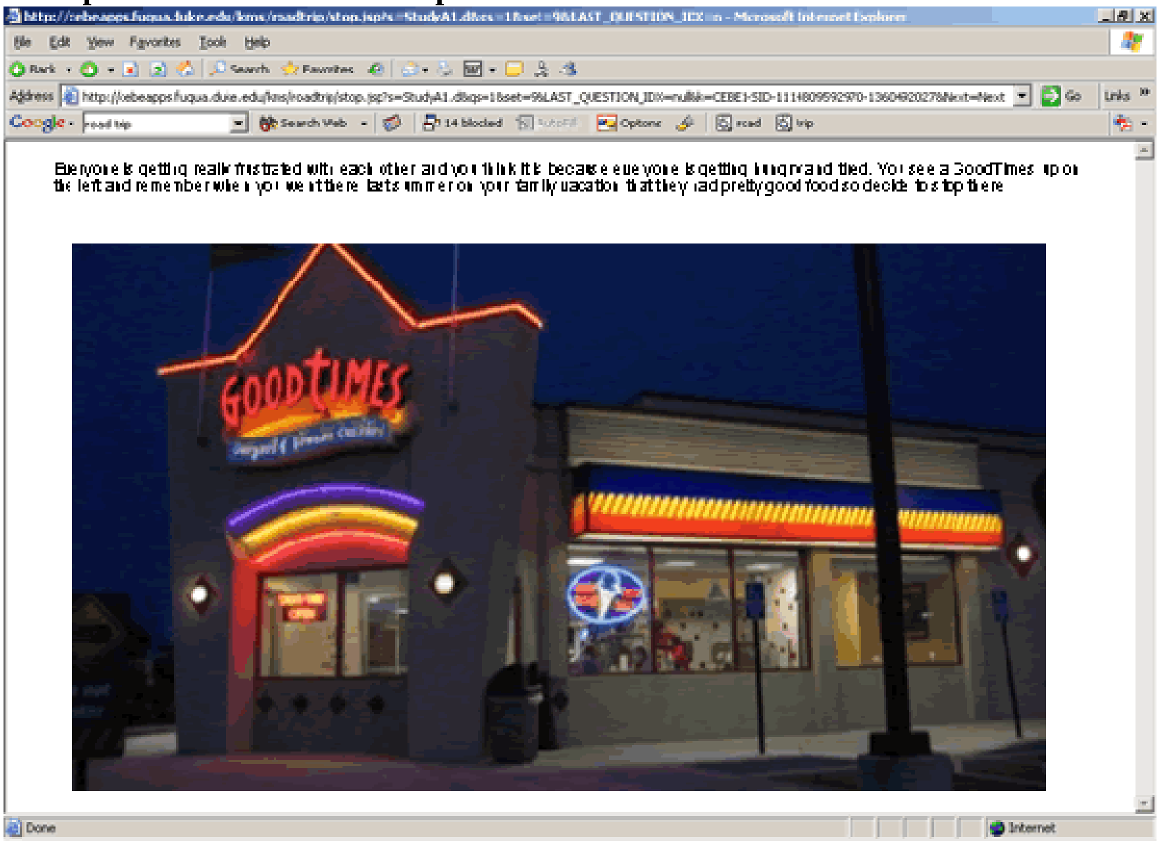
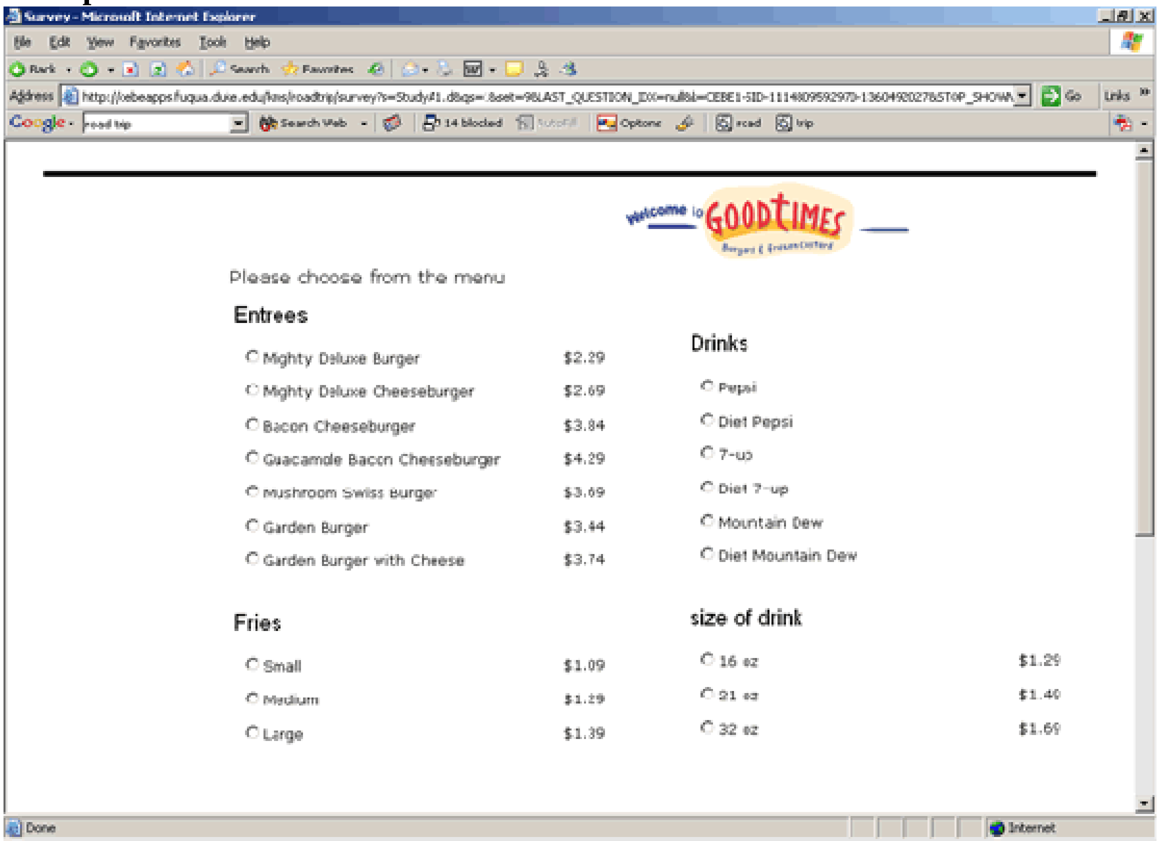


Figure A3

Example menu



Appendix B: Hierarchical Bayes Estimation

The assumption of monotone preference with respect to size implies, in a context-free environment, that everyone values a larger drink at least as much as a smaller drink assuming both are priced equally. We quantify this assumption by defining V_{ij} as follows:

$$V_{ij} = \beta_{i12} x_{12} + \sum_{t=12}^{j} x_t e^{\beta it} \qquad \textbf{(C1)}$$

Where β_{i12} is an individual's parameter for drink size 12oz, β_{it} is the incremental value of a drink size greater than a 12oz, and x_t is a dummy variable for drink size. For example, the value for a 21oz drink size is

$$V_{i21} = \beta_{i12} x_{12} + x_{16} e^{\beta i_{16}} x_{21} e^{\beta i_{21}} \qquad \textbf{(C2)}$$

We assume size choice is captured with a logit choice model implying that the error term in (1) is iid Weibell. Finally, a drink is chosen when

$$U_{ij|k} \geq U_{i0}$$

and size j is chosen when

$$U_{ij|k} > \text{all other } U_{i\cdot|k}$$

Combining these assumptions along with equations (1) and (C1) represents a standard logit choice model.

Estimation is done by first using 16,000 iterations to "burn in" the starting conditions. Thus, another 9,000 iterations are generated and every 100th iteration is kept in order to calculate the individual mean parameter estimates and standard deviation. This implies that we estimate the posterior distribution for each parameter based on 90 (9,000/100) data points.

Appendix C: Policy 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:

$$Prob_i(j|k) = \frac{exp\ (V_{ij} + \lambda_i \bullet \min_{jk} + \gamma_i \bullet \max_{jk} + \tau_i p_j)}{\sum_{j=min}^{max} exp(V_{ij} + \lambda_i \bullet \min_{jk} + \gamma_i \bullet \max_{jk} + \tau_i p_j)} \qquad \textbf{(D1)}$$

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:

$$S_{j|k} = \frac{\sum_{i=1}^{N} Prob_i(j|k)}{N} \qquad \textbf{(D2)}$$

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*:

$$E(profit|k) = \sum_{j=min}^{max}(p_j - c_j) \text{ x } S_{j|k} \qquad \textbf{(D3)}$$

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, i.e.,

$$E(ounces|k) = \sum_{j=min}^{max}(j) \text{ x } S_{j|k} \qquad \textbf{(D4)}$$

Note that imbedded 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.

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TABLE 1: INDICES OF REAL PRICES OF SELECTED FOOD ITEMS AND REAL PERSONAL DISPOSABLE INCOME, ANNUAL AVERAGES

Food Item	Time Period 1966-69	1970-74	1975-79	1980-84	1985-87	Percent change
	(1982-84=100)					
Indices of Real Prices[a]:						
All Food	102.1	106.4	109.6	101.8	99.13	-2.9
Food at home	105.3	106.6	112.3	102.3	97.7	-7.2
Food away from home	93.6	98.4	103.1	100.2	102.1	9.1
Meat, poultry, & fish:	112.4	118.0	118.1	103.5	95.8	-14.8
Meat	112.9	118.9	117.8	103.6	93.8	-16.9
Poultry	149.8	143.2	132.4	104.1	100.7	-32.8
Fish	78.2	90.6	87.7	102.1	107.1	37.0
Eggs	172.6	141.0	141.0	102.5	84.6	-51.0
Dairy Products	118.1	115.8	115.6	103.5	94.4	-20.1
Fats and Oils	106.6	109.8	120.1	103.3	97.9	-8.2
Fruits and Vegetables:						
Fresh	101.1	102.7	105.6	101.1	101.8	.7
Processed	102.3	101.7	108.7	100.3	97.1	-5.1
Flour and Cereal Products	99.5	99.3	106.8	100.6	100.9	1.4
Sugar and Sweeteners	79.0	82.9	105.9	103.4	98.5	24.7
Non-alcoholic Beverages	68.5	69.2	104.2	102.9	97.4	42.2
Real Personal Disposable Income[a]	69.8	81.7	92.7	98.0	111.7	60.0

[a] Nominal terms were converted into real terms by dividing the nominal index by consumer price index of all items.

Source: Charlet and Hennebery (2004): data calculated from USDA.

TABLE 2
RELIABILITY ESTIMATES

Dependent Variable: Dummy coded if the drink choice match			
	Estimate	St. Error	Pr > [t]
Reliability between First Online Choice and Second Online Choice:			
Time 2 – Time 1:			
Core (16 oz – 32 oz)	0.69	0.02	<.0001
Low (12 oz – 32 oz)	0.78	0.02	<.0001
High (16 oz – 42 oz)	0.70	0.02	<.0001
Change in Reliability between Second Choice and Third Choice			
Time 3 – Time 2	0.06	0.02	0.0096
Change in Reliability between Consumption Task and Third Online Choice:			
Time 4 – Time 3	-.099	0.05	0.0360
Additional Change in Reliability due to a Tighter Budget Constraint			
Budget = $6.00	-.097	0.07	0.1921

TABLE 3
PARTICIPANT DEMOGRAPHICS

Ethnic Category	Gender Females	Males	Not Specified	Total
Hispanic or Latino	23	22		45
Not Hispanic or Latino	132	126	1	259
Total All Subjects	155	148	1	304
Racial Categories				
American Indian/Alaska Native	1	1		2
Asian	6	5		11
Native Hawaiian/Pacific Islander	1	-		1
Black or African American	20	18		8
White	118	117		235
Two or More Races	5	6	1	12
Not Specified	4	1		5
Total All Subjects	155	148	1	304

TABLE 4
DRINK PORTFOLIO CONDITIONS

Set	Drink Sizes Available				
Core		16oz	21oz	32oz	
High		16oz	21oz	32oz	42oz
Low	12oz	16oz	21oz	32oz	
Full	12oz	16oz	21oz	32oz	42oz
No 21oz	12oz	16oz		32oz	42oz

TABLE 5
CONJOINT CHOICE SETS AND PRICES

Sizes/Set	1	2	3	4	5	6	7	8	9	10	min	max	range
12 oz		$0.99			$1.39					$0.99	$0.99	$1.39	$0.40
16 oz	$1.04	$1.04	$1.49	$1.35		$1.49		$1.29		$1.35	$1.04	$1.49	$0.45
21 oz	$1.34		$1.69	$1.59	$1.59	$1.69	$1.59	$1.49	$1.34	$1.59	$1.34	$1.69	$0.35
32 oz	$1.49	$1.49	$1.55	$1.89	$1.69		$1.89	$1.69	$1.59		$1.49	$1.89	$0.40
44 oz	$1.69	$1.89	$1.75			$1.75	$2.01		$1.65		$1.69	$2.01	$0.32

TABLE 6
STUDY 2 EXTREMENESS AVERSION RESULTS

Parameter	Estimate	t Value
Same Format Changes		
None	5.80	10.61
_12oz	1.18	2.17
_16oz	0.20	0.61
_21oz	-0.56	-1
_32oz	-3.38	-5.33
_44oz	-7.29	-6.37
Different Format Changes		
Drop 12 oz		
_12oz	2.86	3.73
_16oz	1.33	1.99
_21oz	0.76	0.75
_32oz	4.04	3.18
_44oz	0.04	0.03
Add 12 oz		
_16oz	-2.91	-5.49
_21oz	-1.49	-1.59
_32oz	-1.25	-1.24
Drop 44 oz		
_12oz	-1.03	-1.34
_16oz	-0.98	-1.46
_21oz	-0.84	-0.83
_32oz	-2.58	-2.03
_44oz	-8.21	-5.07
Add 44 oz		
_16oz	0.17	0.31
_21oz	1.05	1.12
_32oz	6.63	6.61

TABLE 7
POPULATION MEAN ESTIMATES (STANDARD DEVIATIONS)

Variable	Mean	(std)	Variable	Mean	(std)
12oz	7.47	(4.40)			
16oz	15.54	(22.63)	Price Sensitivity ($\tau_{.}$)	-6.91	(4.33)
21oz	20.94	(39.96)			
32oz	24.62	(52.34)	Smallest Size (λ.)	.60	(2.3)
42oz	24.73	(52.34)	Largest Size (γ.)	-2.42	(2.85)

TABLE 8
EXAMPLE INDIVIDUAL (#92)
MEAN PARAMETER ESTIMATES

Variable	V_{ij}	Variable	Estimate
12oz	4.89		
16oz	7.21	Price Sensitivity ($\tau_{29.}$)	-4.84
21oz	7.52		
32oz	7.64	Smallest Size (λ_{29})	-1.60
42oz	7.80	Largest Size (γ_{29})	-.84

TABLE 9
UTILITY FOR 12oz-42oz VS 16oz-42oz

Sizes	12oz-42oz U_{29j}	16oz-42oz U_{29j}
12oz	-1.97	
16oz	.97	-.63
21oz	.31	.31
32oz	-.53	-.53
42oz	-2.18	-2.18

TABLE 10
VARIABLE COST PER DRINK SIZE

Size	Cup	Lid	Soft drink	Total Cost	Profit[19]
None[20]	$ 0.02	$ 0.01	$ -	$ 0.03	($0.03)
12	$ 0.02	$ 0.01	$ 0.09	$ 0.12	$0.97
16	$ 0.03	$ 0.01	$ 0.12	$ 0.16	$1.13
21	$ 0.03	$ 0.01	$ 0.16	$ 0.19	$1.30
32	$ 0.05	$ 0.01	$ 0.24	$ 0.30	$1.39
42	$ 0.06	$ 0.02	$ 0.32	$ 0.40	$1.49

Source: personal communications with industry source

[19] Based on prices set in the “road trip” experiment.
[20] It cost the firm to provide a cup and a lid for those who order a cup of water.

TABLE 11
POLICY EXPERIMENT RESULTS
Profit Maximizing Portfolio in Bold

BASELINE Portfolio	Avg. Profit per Customer	Avg. Size (ounces)	Avg. Size % Change	Avg. $ per Customer	$ per Customer % Change	Market Share None	12oz	16oz	21oz	32oz	42oz
High (16oz-42oz)	**$1.20**	**20.6**		**$1.39**		**8%**		**32%**	**36%**	**22%**	**2%**
Full (12oz-42oz)	$1.19	19.2	-7%	$1.38	-1%	7%	16%	29%	28%	20%	2%
Core (16oz-32oz)	$1.18	18.9	-8%	$1.36	-2%	8%		34%	47%	12%	
Low (12oz-32oz)	$1.18	17.7	-14%	$1.34	-3%	7%	17%	31%	34%	11%	
FLAT TAX Portfolio	**Avg. Profit per Customer**	**Avg. Size (ounces)**	**Avg. Size % Change**	**Avg. $ per Customer**	**$ per Customer % Change**	**Market Share None**	**12oz**	**16oz**	**21oz**	**32oz**	**42oz**
High (16oz-42oz)	$1.06	18.5	-10%	$1.46	5%	19%		25%	33%	22%	2%
Full (12oz-42oz)	**$1.12**	**17.2**	**-16%**	**$1.45**	**4%**	**14%**	**24%**	**19%**	**23%**	**19%**	**1%**
Core (16oz-32oz)	$1.04	16.8	-18%	$1.42	2%	20%		26%	43%	11%	
Low (12oz-32oz)	$1.05	16.0	-22%	$1.44	3%	17%	14%	26%	32%	10%	
GRADUATED TAX Portfolio	**Avg. Profit per Customer**	**Avg. Size (ounces)**	**Avg. Size % Change**	**Avg. $ per Customer**	**$ per Customer % Change**	**Market Share** None	**12oz**	**16oz**	**21oz**	**32oz**	**42oz**
High (16oz-42oz)	$1.11	18.8	-9%	$1.43	3%	15%		32%	32%	21%	1%
Full (12oz-42oz)	**$1.15**	**17.4**	**-15%**	**$1.43**	**3%**	**12%**	**16%**	**31%**	**23%**	**17%**	**1%**
Core (16oz-32oz)	$1.10	17.1	-17%	$1.39	0%	16%		34%	41%	10%	
Low (12oz-32oz)	$1.12	16.1	-22%	$1.39	0%	13%	17%	34%	28%	9%	
CAFÉ-LIKE STANDARD Portfolio	**Avg. Profit per Customer**	**Avg. Size (ounces)**	**Avg. Size % Change**	**Avg. $ per Customer**	**$ per Customer % Change**	**Market Share None**	**12oz**	**16oz**	**21oz**	**32oz**	**42oz**
High (16oz-42oz)	$0.60	18.5	-10%	$0.77	-44%	1%		76%	11%	11%	1%
Full (12oz-42oz)	$1.14	18.5	-10%	$1.32	-6%	5%	26%	28%	22%	18%	2%
Core (16oz-32oz)	$1.12	18.6	-10%	$1.30	-7%	6%		46%	37%	11%	
Low (12oz-32oz)	**$1.18**	**17.7**	**-14%**	**$1.34**	**-4%**	**7%**	**17%**	**31%**	**34%**	**11%**	