

Assessing the USDA Report, “Taxing Caloric Sweetened Beverages: Potential Effects on Beverage Consumption, Calorie Intake, and Obesity” by Travis A. Smith, Biing-Hwan Lin, and Jonq-Ying Lee

Jonathan Klick¹

Executive Summary:

Using a large dataset of consumer purchases and price information from store checkout scanners, Smith, et al. estimate the price elasticities and cross price elasticities of a set of commonly consumed beverages. Using this estimated demand system, the researchers simulate the effect of a 20 percent increase in the price of caloric sweetened beverages in terms of the net change in calories consumed based on survey data of individual consumption levels of the analyzed beverages. Their results suggest that, on average, this price increase would lead to a reduction of 37 calories per day for adults and 43 calories per day for children. Based on assumptions about the relationship between net calorie intake and body weight, they claim this calorie reduction would lead to a loss of 3.8 pounds for adults and 4.5 pounds for children over the course of a year. They further claim that this weight reduction would lower the incidence of being overweight 4.5 percent and the incidence of obesity among adults by 3 percent. They claim there would be comparable effects among children.

These conclusions stand in contrast to numerous studies examining *actual* effects of price changes, which generally find a negligible effect of increasing prices for caloric sweetened beverages on body weight, for both adults and children. Smith, et al. suggest that the failure to find an association between price increases and body weights is not surprising. They suggest that actual prices changes are too small and infrequent to generate a substantial effect, which explains their choice to use a very large price

¹ Professor of Law, University of Pennsylvania Law School. J.D., George Mason University; Ph.D. (economics), George Mason University. This paper was supported in part by a general grant to the author from the International Center for Law and Economics, without any restrictions as to its use. The ICLE receives grants and donations from several organizations, including the American Beverage Association. None of these organizations, including the ABA, had any input in the writing of this paper, which solely represents the intellectual work and views of the author.

change in their simulation. Further, they claim that studies focusing on tax changes are problematic since taxes are not included in the list price of beverages, suggesting that people do not realize taxes will be added to the price of their beverage purchases.

While each of these claims is possible, it is troubling that the results of this study stand in such contrast to the literature published in peer reviewed public health and economics journals. Further, although taxes are smaller than the 20 percent simulated tax change, they are not trivial, averaging above 5 percent in the 33 states that levied sales taxes on soda in 2009. It is also interesting that this tax rate differential exceeds the percentage difference between the average prices of the caloric sweetened beverages and many of the “healthful” substitutes used by Smith, et al. to estimate their demand system. The authors are silent as to whether the magnitude of price changes for the products used to estimate their demand system are substantially higher than these tax rates that are too small to plausibly have an effect. However, examining the range of the prices charged for the caloric sweetened beverages in their dataset, and adjusting for price inflation during the period 1998-2007, it appears as though the price changes they use to generate their estimates are actually smaller than the actual sales taxes charged. This suggests a large inconsistency between Smith, et al.’s results and the published scientific literature.

Smith, et al. suggest that another benefit of their simulation is its ability to account for substitution effects among beverages of varying degrees of healthfulness. This claim, however, relies on the assumption that all important substitute channels have been analyzed, as the authors themselves admit. Given this, it is disconcerting that the authors fail to account for very important substitutes. Of specific interest with respect to adults is the possibility that people switch to beer, wine, or alcohol in the face of higher caloric sweetened beverage prices. Each of these alcoholic beverages has comparable or worse caloric content than do the caloric sweetened beverages analyzed. The failure to account for this substitute channel alone could be enough to invalidate their conclusions. Among children, a similar omission occurs in their failure to account for substitution to non-powder based (e.g., syrup based or pre-mixed) chocolate milk which has almost two and half times the number of calories that are contained in the average non-diet soda. Again, these failures significantly reduce confidence in any conclusions based on Smith, et al.’s simulation.

An additional major flaw in the Smith, et al. simulation is that it uses average estimates of price elasticities and the resulting effects on beverage consumption to then draw conclusions about the effect of a price increase on obesity incidence. However, the individuals who are close to the overweight or obese thresholds may exhibit very different demand behavior than the average consumer. For example, if obese people are less price sensitive than the non-obese, Smith, et al.'s claim that a 20 percent price increase would likely lead to a 3 percent reduction in the obesity incidence would represent an upwardly biased estimate. Because Smith, et al. have no weight characteristics in their scanner data, it is impossible for them to rule out this possibility.

In sum:

1. The authors' decision to exclude certain beverages (notably chocolate milk and alcoholic beverages) and all non-beverage items from their analysis calls into question their estimates of the effect on body weight of a price increase in caloric sweetened beverages.
2. Instead, it is quite likely that some of the estimated weight loss from the substitutions identified by the authors (from non-diet soda to low-fat milk or juice, for example) might disappear in the real world when consumers substitute from these beverages to beer, wine, or chocolate milk.
3. The study's conclusions hinge on consumers moving between clinical designations ("obese" to "overweight, for example), even though the actual amount of weight loss is quite small and the resulting health effects do not turn on the clinical designation but rather on overall weight.
4. The study does not consider how metabolism, and thus both consumption patterns as well as the relationship between calorie intake and weight, can be expected to change in response to changes in body composition. By extrapolating long-term effects from single-year results the authors thus assume a constant metabolic environment and consistent preferences. These assumptions are not realistic.
5. Individuals who are close to the overweight or obese thresholds may

exhibit very different demand behavior (and different metabolisms) than the average consumer, again calling into question the broader extrapolation of data in the study.

6. Smith et al.'s estimates of the underlying demand system are problematic as underscored by the odd finding that consumers view diet beverages and non-diet beverages as complements, rather than substitutes based on the estimates using scanner data. This is almost certainly evidence of statistical bias.

Because of these limitations, the study does not effectively answer the questions essential to assessing the effect of a beverage tax on weight or overall health: 1) how large of a decrease in caloric sweetened beverage consumption would result from a tax?, 2) what products (including non-beverage products), if any, will consumers consume instead of caloric sweetened beverages?, 3) what healthful products or activities, if any, will consumers give up in order to spend more of their income on taxed beverages?, and 3) are the resulting shifts likely to have a significant—or even merely positive—affect on weight or other health effects, much less significant long term effects?

There are a significant number of other problems with the Smith, et al. simulation. Together with those described above, it is clear that it does not provide a sound basis for drawing policy conclusions. Until these limitations are remedied, the most prudent response is to rely on the existing peer reviewed scientific literature that suggests there is little effect of increasing prices of caloric sweetened beverages on ultimate body weight. This suggests that any policy response to increasing rates of obesity should look to other channels to improve individual health.

Assessing the USDA Report, “Taxing Caloric Sweetened Beverages: Potential Effects on Beverage Consumption, Calorie Intake, and Obesity” by Travis A. Smith, Biing-Hwan Lin, and Jonq-Ying Lee

Jonathan Klick²

Using a large dataset of consumer purchases and price information from store checkout scanners, Smith, et al.³ estimate the price elasticities and cross price elasticities of a set of commonly consumed beverages. Using this estimated demand system, the researchers simulate the effect of a 20 percent increase in the price of caloric sweetened beverages in terms of the net change in calories consumed based on survey data of individual consumption levels of the analyzed beverages. Their results suggest that, on average, this price increase would lead to a reduction of 37 calories per day for adults and 43 calories per day for children. Based on assumptions about the relationship between net calorie intake and body weight, they claim this calorie reduction would lead to a loss of 3.8 pounds for adults and 4.5 pounds for children over the course of a year. They further claim that this weight reduction would lower the incidence being overweight 4.5 percent and the incidence of obesity among adults by 3 percent. They claim there would be comparable effects among children. As I will detail below, these claims are questionable.

1. Review of USDA methods and results

Smith and co-authors use data collected from store checkout scanners to estimate price elasticities and cross price elasticities for a number of different beverage products,

² Professor of Law, University of Pennsylvania Law School. J.D., George Mason University; Ph.D. (economics), George Mason University; M.S., University of Maryland. This paper was funded in part by a general grant from the International Center for Law and Economics for academic writings and public policy outreach on beverage tax issues, as part of the ICLE's Antitrust and Consumer Protection Program, without any restrictions as to its use. While the author understands that the American Beverage Association has been a contributor to ICLE, neither the ABA nor any of its members had any input in the writing of this paper. This paper solely represents the views of the author.

³ Smith, Travis A., Biing-Hwan Lin, and Jonq-Ying Lee, “Taxing Caloric Sweetened Beverages: Potential Effects on Beverage Consumption, Calorie Intake, and Obesity,” *ERR-100*, U.S. Department of Agriculture, Economic Research Service, July 2010, available at <http://www.ers.usda.gov/Publications/ERR100/>.

including caloric sweetened beverages like non-diet sodas.⁴ Using this demand system, they calculate the effect a 20 percent price increase would have on the consumption of these beverages based on the self-reported consumption habits of 8,460 adults and 7,365 children surveyed in the National Health and Nutrition Examination Survey (NHANES).

Smith, et al. admit that their hypothesized price increase of 20 percent is well outside of the variation they use to estimate the price elasticities upon which all of their conclusions stand. While such price elasticity calculations are generally viewed as being reliable for small price changes, they are unreliable for large price changes, especially if the assumed price change is outside of the sample range used to estimate the elasticity. While Smith, et al. suggest that out-of-sample predictions may understate elasticities (p. 10), it would be more accurate to suggest that out-of-sample predictions are simply unreliable, and it is not possible to predict the direction or magnitude of any bias that arises.

Despite this reliability problem, Smith, et al. calculate the differential in calories consumed that is implied by this 20 percent price change using information reported by each NHANES respondent. This simulation suggests that the average consumer would reduce daily calorie consumption by 37 calories for adults and 43 calories for children. Based on an assumption of how many calories are required to sustain a pound of body fat, they conclude that these calorie reductions would lead to a loss of 3.8 pounds for the average adult and 4.5 pounds for the average child over the course of a year.

Based on this simulation, Smith, et al. then examine the effect of this hypothetical price increase on the consumption patterns of the individuals in the NHANES sample for these beverages. Combining the change in beverage consumption with the assumed effect on body weight for the calorie reduction, the USDA staff members estimate how many individuals would move from being categorized as overweight to not being

⁴ A price elasticity is the percentage change in the quantity of a good purchased when the good's price increases by one percent. Cross price elasticities are calculated with respect to a one percent price change of some other, often substitute, good. While it is intuitively obvious why the sales of a good may decline when its price increases, it is harder to predict what will happen to sales of a good when the price of some other good changes. If the goods are substitutes, such as juice and soda, an increasing price for the one may lead consumers to switch to the other since it is now relatively less expensive.

overweight, as well as from being categorized as obese to not being obese.⁵ They estimate that the incidence of being overweight among adults might decline by 4.5 percent and the obesity incidence might decline by 3 percent under the simulated price increase. For children, the effects are estimated to be 5.3 percent and 2.9 percent respectively.

2. *Incongruence with scientific literature*

As Smith, et al. rightly point out, their simulation results differ substantially from the estimates published in peer reviewed scientific journals. For example, the Powell, et al. paper cited in the USDA report,⁶ which includes a very rich set of control variables, not only fails to find a statistically significant reduction in adolescent BMI related to soda taxes, its estimates imply that soda taxes are associated with *higher* levels of BMI. These results are very robust across empirical specifications.

The 2010 article in Health Affairs by Sturm, et al. arrives at the same conclusion.⁷ That is, they, too, find little evidence that an increase in soda taxes leads to any discernible effect on the body weight of adolescents. Fletcher, et al.'s 2010 Health Affairs article also finds little relationship between soda taxes and body weights.⁸ Similar results hold for adults.⁹ Because these studies adopt a robust methodology (evaluating consumption changes in response to price changes that are *not* plausibly the result of consumption changes, but rather the result of external supply changes or the like), and because each contains very detailed control variables, these studies provide the best opportunity to isolate any causal effect of price changes for caloric sweetened beverages on body weight. The fact that these high quality studies, among others not cited in the USDA report, using numerous different datasets, all converge on the result that there is

⁵ For adults, this categorization is based on a BMI of 25 for overweight and 30 for obese. For children, the comparable categories are "at risk for being overweight" and "overweight" respectively and are based on cutoffs in the distributions used for child growth charts.

⁶ Lisa Powell, Jamie Chriqui, and Frank Chaloupka, "Associations between State-level Soda Taxes and Adolescent Body Mass Index," *Journal of Adolescent Health*, 45: S57-S63 (2009).

⁷ Roland Sturm, Lisa Powell, Jamie Chriqui, and Frank Chaloupka, "Soda Taxes, Soft Drink Consumption, and Children's Body Mass Index," *Health Affairs*, 29(5): 1052-1058 (2010).

⁸ Jason Fletcher, David Frisvold, and Nathan Tefft, "Taxing Soft Drinks and Restricting Access to Vending Machines to Curb Child Obesity," *Health Affairs*, 29(5): 1059-1066 (2010).

⁹ Jason Fletcher, David Frisvold, and Nathan Tefft, "Can Soft Drink Taxes Reduce Population Weight?," *Contemporary Economic Policy*, 28(1): 23-35 (2010).

no relationship between beverage prices and BMI, creates a very strong rebuttable presumption in favor of this conclusion. To overturn this presumption requires very strong evidence from high quality statistical designs. Unfortunately, the Smith, et al. statistical design is not very robust.

3. Methodological design problems

Estimating the demand curve for beverages is the building block of all economic analyses predicting how beverage taxes may affect consumption patterns.

In essence, the researcher evaluates those estimated consumption patterns using assumptions about the caloric density of the beverages consumed, and calculates how observed changes in calorie consumption caused by changes in price will affect body weight and obesity. One can think of a demand curve as a line, sloping downward from left to right, identifying the quantity of caloric sweetened beverages consumers would like to purchase at each given price. To estimate a demand curve, it is critical that the researcher observe the amount of beverages sold at different prices.

The authors find this requisite variation in prices by looking at nationwide sales of their included beverages over 120 months. An alternative approach frequently employed to estimate demand curves is to take advantage of so-called “natural experiments” in prices (e.g., a change in taxes or well-defined increase in the cost of production) and compare consumption before and after the experiment, or between jurisdictions affected by the experiment and those that were not. The Smith, et al. study has no such “policy variation” on which to base its demand curve estimate.

The advantage of the natural experiment approach is that the changes in prices are “exogenous” – meaning that there is no hidden causal relationship between price and consumption that might negate or call into question the results. The USDA study’s approach is weaker and produces less reliable estimates because the variation in prices over time that the authors use to estimate consumer preferences and substitution patterns are controlled by the suppliers.

Think of the classic randomized controlled experiment where one group of patients is

given a medication and the second group is given a placebo. Assignment into both groups is random. One can then compare the effect of taking the drug with taking the placebo to evaluate efficacy. If subjects are allowed to select into the “treatment” or “control” groups, for example, sicker patients might opt-in to former, while healthy patients opt for the placebo. In this case, one would predictably find that, after the experiment, the sicker patients improved and the placebo had little effect. But such estimates of the efficacy of the drug would overstate its effectiveness since only sick patients took it.

In the same fashion, observed changes in consumption of caloric sweetened beverages and changes in price are related, such that the variation over time in prices reflects differences in consumer demand while, at the same time, consumer demand reflects differences in price. Researchers are unable to control for many of the things that affect both consumer demand and price. Thus, the two variables are said to be “endogenous.” Using differences in prices at two different points in time to tell us something about how consumer behavior will change in response to price is problematic precisely because changes in consumer behavior may very well have generated the different prices in the first place. This would not be the case if, for example, consumer preferences never changed over time (i.e., at every point in time, consumers would demand the same amount of caloric sweetened beverages at any given price), or if all price changes were caused by exogenous changes on the supply side (e.g., because of well-defined changes in labor costs or supply prices). But these are extremely unrealistic assumptions. Among many other things, as consumers learn more about the possible health effects of excessive caloric intake, their willingness to consume calories (from whatever source), even at a constant nominal price, has surely changed. Likewise, as improved low-calorie products have been introduced, palates have changed, and cultural pressures shifted, it is almost certain that preferences for various beverages and types of beverages have also changed, independently of price.

As a result, the derivation of a demand curve from the data used in the Smith, et al. study represents an unreliable estimate of how demand for caloric sweetened beverages would change in response to a change in price. As noted, the Smith, et al. results are, in fact, at odds with several other studies that have employed more reliable statistical designs.

4. Problems with the size of the simulated price change

Smith, et al., however, claim that a major reason no effect is discovered in these other studies is that state soda taxes are too small to have any significant effect. This claim is problematic in light of Smith, et al.'s own results. Specifically, they point out that state soda taxes average more than 5 percent in the 33 states that taxed soda in 2009 (p. 2). But if this price increase is too small to generate any significant change in behavior, it seems odd that Smith, et al. generate estimates implying significant behavioral changes derived from price variation that is *even smaller* than this 5 percent figure.

In Smith, et al.'s paper, the range of nominal prices in their data goes from \$2.32 to \$3.04 per gallon for caloric sweetened beverages over the period 1998-2007. U.S. prices in general rose by 27 percent over the same period.¹⁰ As a result, the maximum real price increase observed over the entirety of their data could have been as small as 3 percent.¹¹ Comparably small price differences exist in the cross section between the caloric sweetened beverages and a number of the milk products, for example. If the soda tax rates analyzed in the other studies are too small to expect any behavioral change, it is troubling that a much smaller change generates significant consumption effects in the USDA simulation. Smith, et al. offer no direct explanation for why a relatively small price increase in their data suggests changes in purchasing behavior and, ultimately, a reduction in BMI in their simulations, while analyses of real world data identify no such change on the basis of even larger tax-induced price changes.¹²

Perhaps an implicit answer to this comes from Smith, et al.'s suggestion that consumers do not account for sales taxes when making purchasing decisions since taxes are not included in list prices in the U.S. (p. 2). Presumably the story is that consumers react to

¹⁰ <http://data.bls.gov/cgi-bin/cpicalc.pl>

¹¹ Appendix Table 3 (p. 24) provides the minimum and the maximum price observed in the dataset. While it is not possible to discern from the USDA report whether the minimum was observed at the beginning of the sample period and the maximum at the end, this is probably a reasonable approximation.

¹² Note that this is not simply an issue of Smith, et al. basing their simulation on a 20 percent price increase, since they first need to identify purchasing behavior changes in the face of 3 percent price changes. The soda tax studies examine larger price increases, with many of them finding an *increase* in body weight or else fairly precisely estimated zero effects. Thus, the existing literature cannot be explained away on the basis of a lack of statistical power in the research designs.

list prices because they are salient, whereas the sales tax component of price is hidden. The plausibility of this argument is questionable since it requires a belief not only that consumers are surprised by soda taxes after the purchasing decision has already been made, but also that these consumers make this same mistake over and over again.

An additional problem arises for Smith, et al. in making this claim. Given the small price changes they observe in their data, and the fact that most states had soda taxes in place for much of their sample period, a large portion of the price variation they observe is, in fact, the result of taxes both across beverages and across time. Thus, it is either the case that consumers do actually respond to the tax component of price, even if it is not included in the list price, or Smith, et al. identify absolutely huge purchasing changes as a result of extremely tiny real pre-tax price changes. The latter interpretation strains credulity; the former interpretation, while being completely plausible, begs the question why the research using real data to estimate BMI changes resulting from soda tax changes finds no effect, whereas the USDA simulation finds large effects.

In sum, there are very large differences between the estimates of the effect of caloric sweetened beverage price increases based on the USDA's simulation and estimates using real data. The scientific literature in this area is large and is mostly in agreement that the data do not show a significant negative relationship between caloric sweetened beverage prices and body weights.

5. Failure to include important substitute beverages and non-beverage substitutes

The USDA simulation also suffers from a very large methodological flaw. Smith, et al.'s estimates of the beverage price elasticities, the foundation of their analysis, require that they include all important substitute beverages in their estimates. As they state (pp. 9-10), "failure to incorporate alternative beverages would bias an assessment of the calorie-reduction effect from a tax. Furthermore, not including alternative beverages to estimate a beverage demand system would result in model misspecification and bias estimates of demand elasticities." Although they leave it implicit, it is clear from this statement that excluding important alternative beverages not only biases the elasticity estimates, but it also biases the body weight change estimates since their simulation

relies on these elasticity estimates. And even though Smith, et al. focus their analysis on a beverage-only demand system, the same problems would arise from the failure to include alternative, non-beverage sources of calories (including candy and other snack foods).¹³

Table 3 (p. 10) presents the list of included beverages: caloric sweetened beverages; diet beverages; skim milk; low-fat milk; whole milk; juices; coffee/tea; and bottled water. Surely there are many other important beverages that serve as substitutes for caloric sweetened beverages. Just to mention a single important category, Smith, et al. leave out any possible substitution to beer, wine, and other alcoholic beverages. Such an omission is particularly troubling given that the calorie content of these beverages equals or exceeds that of non-diet sodas, juices, and even whole milk as shown in Table 1:

Included Beverages	Calories per 8 ounces
Whole Milk	149
Apple Juice	114
Non-diet Cola	91
Omitted Beverages	Calories per 8 ounces
Beer	102
Wine	194
Liquor	> 500
Chocolate Milk	208

While the omission of alcohol presumably does not affect the Smith, et al. estimates for children, there are numerous other alternate beverages that are not included despite being favored by many children. To cite one example, the demand system estimated by Smith, et al. does not include chocolate milk made from syrup or pre-made chocolate

¹³ It is easy to imagine beverage and food linkages that would lead to biases. For example, if parents ration “treats” to their children, when the price of soda increases, parents may be more apt to substitute toward candy. For adults, a similar internal mechanism may apply as an individual may reward herself with candy for abstaining from soda.

¹⁴ Calorie content for Whole Milk, Apple Juice, and Non-diet Cola come from Smith, et al. Figure 3 (p. 9). Other calorie content information provided by <http://caloriecount.about.com/>

milk. The calorie content from chocolate milk exceeds that of all included beverages, leaving the potential for a large bias in the ultimate estimates in the USDA report.

At the same time, Smith, et al. fail to consider substitution from caloric sweetened beverages into non-beverage substitutes like candy and other snacks. Like the omitted beverage substitutes, these foods may pose similar or even worse health risks. To the extent that consumers substitute high-calorie foods for caloric sweetened beverages (choosing a candy bar over a sugar-sweetened soda, for example), this form of substitution would likewise bias the authors' weight loss estimates.

By the authors' own account, omissions such as these are guaranteed to lead to biases in the underlying estimates. These biases make the ultimate conclusions unreliable for the purposes of making public policy decisions.

6. The weight loss involved is modest, so overweight/obesity effects are partly "threshold effects"

The authors emphasize that part of the reduction in overweight and obesity is due to the fact that there are nontrivial shares of people just to the right of the BMI cutoff points for both overweight and obesity. Thus, if everyone in a sample experiences even a relatively small drop in weight, there will be reductions in the number of consumers classified as overweight or obese as some people move from just right of the cutoff to just left of it. Unless there is something magical about the cutoffs chosen for labeling people overweight or obese, it seems unlikely that such "threshold-effect" reductions in overweight/obesity are particularly meaningful from a health perspective, over and above the health advantages that come from a simple reduction in BMI.¹⁵ The authors estimates of 3.8 pound weight loss for adults and 4.5 pounds for children are relatively small in magnitude in the sense that one would not expect a 4 pound reduction in body weight to have significant health advantages, even though, given this clustering, such weight reductions could move significant numbers of people from worse to better

¹⁵ To be sure, the authors do state that some of the drop in overweight/obesity is due to the fact that "[m]any overweight and obese Americans consume large amounts of caloric sweetened beverages." (Page iv.) Perhaps, then, policies that lead to relatively small changes in average weight also lead overweight or obese people to lose greater than average amounts of weight.

clinical designations.¹⁶

Thus to the extent that the authors claim that such losses would “reduce obesity,” it is largely because (as the authors recognize, to their credit) there are a large number of people just over the BMI cutoff points for “overweight” and “obese.” As a definitional matter, for these people clustered near the cutoffs, even a small reduction in weight could move them from “obese” to “overweight” or from “overweight” to “normal,” even though as a practical matter the reduction in weight is small and the actual health effects may also be small.

For example, there is no reason to believe that a 4 pound weight reduction for a 183 pound, 5 ft 11 in male is appreciably more significant than a 4 pound weight reduction for a 185 pound, 5 ft 11 in male, even though the former moves from “overweight” to “normal,” while the latter remains “overweight.” These cutoffs are not particularly meaningful from a health perspective. Thus, the stated reduction in overweight/obesity rates is largely a statistical artifact of these arbitrary BMI cutoffs, rather than an indication of real health effects.

7. Average effects may diverge from individual effects

Another problem with respect to the methodology involves a potential mismatch between the elasticity estimates and the resulting weight loss estimates. Specifically, the elasticity estimates are averaged over all individuals. These average elasticities are then applied to specific individuals’ consumption bundles and body weights. It is by doing this that Smith, et al. generate their estimates of the change in incidence of being overweight or obese that would accompany a 20 percent price increase for caloric sweetened beverages.

¹⁶ Also of potential importance is the fact that Smith et al do not discuss whether they use the measured or self-reported height and weight measures from the NHANES. Previous researchers have identified substantial (and systematic) differences between these measures suggesting that individuals do not accurately report height and weight. If the self report data are used, this clustering may not be real but rather may be the result of heavier individuals reporting they are closer to the clinical thresholds than is actually the case. Under this scenario, the changes in obesity and overweight incidence reported by Smith et al are even less important than I have suggested.

There is no way to know which kinds of individuals are driving the elasticity estimates, however. Perhaps thin people, who exhibit self discipline, also exhibit fiscal discipline. Such a relationship would imply that their buying habits would exhibit a high degree of price sensitivity. This would imply that when prices decline, these people substitute toward the cheaper good at a significantly higher rate than do others. In this hypothetical world, individuals with higher BMIs would exhibit less price sensitivity than average, and so the resulting BMI changes suggested by the USDA simulation would be significantly overstated. Under this set of assumptions, the true change in the incidence of being overweight or obese would not be expected to change very much even in the face of a 20 percent price increase.

Related, while the figures given are for a single year and thus could end up being far more significant if the same weight-loss pattern persisted over a long time, this assumption (looking only at single year effects and then extrapolating a larger effect over time) is troubling. In particular, this kind of study does not consider how metabolism, and thus both consumption patterns as well as the relationship between calorie intake and weight, can be expected to change in response to changes in body composition. The 3.8 pound weight loss in year one may amount to only a 2 pound weight loss in year two, even with exactly the same consumption pattern. Moreover, consumption patterns themselves may change, and consumers may consume more caloric sweetened beverages (even at a higher price) as their body weight decreases (in effect making the consumption of calories less costly for the now relatively-healthier consumer), leveling off or even ultimately reversing the weight loss. These common sense facts render the extrapolation of “year one” effects unreliable.

Because the scanner data used by Smith, et al. has no information about the purchasers’ body weights nor consumers’ metabolic changes over time, it is not possible to examine how price sensitivity varies by BMI. This problem also undermines the reliability of the USDA’s methodology and any conclusions drawn from it.

8. *Evidence of the simulation’s bias: The conclusion that diet and non-diet sodas are complements rather than substitutes*

The Smith, et al. study contains within it a curious finding that supports skepticism of

the authors' estimates: According to the study's estimates, consumers view diet beverages and caloric sweetened beverages as complements, and Smith, et al. find a strong, positive correlation between caloric and diet beverages.¹⁷ In other words, the estimates imply that when consumers' purchase more Coke, they also purchase more—rather than less—Diet Coke. Because this result appears contrary to intuition about beverage consumption patterns, it casts doubt over the demand estimates the authors generate to make predictions about the effect of a sweetened beverage tax.

In addition, this estimate is inconsistent with experimental evidence. One oft-cited study has shown that children will substitute from full-priced caloric sweetened beverages to free, non-caloric beverages when presented with the choice.¹⁸ This is consistent with diet beverages and caloric sweetened beverages as *substitutes* and not *complements*, as the USDA study suggests, and it thus calls into question the reliability of the Smith, et al. analysis.

There is, of course, no debate that demand for caloric sweetened beverages decreases as prices increase, and that some of this consumption would shift into diet beverages if their prices remained the same while caloric sweetened beverage prices increased. It is thus not surprising that, faced with a choice between free (home-delivered, as it happens) diet beverages and full-priced caloric sweetened beverages, children chose the former. That fact says a lot about the reliability of a study that predicts, instead, that the availability of free diet beverages would have *increased* children's consumption of caloric sweetened beverages. It says very little about the efficacy of taxing caloric sweetened beverages as a way to induce consumption of diet beverages instead of caloric sweetened beverages, however.

Any caloric sweetened beverage tax is likely to result in reduced consumption, whether or not that reduced consumption results in increased diet drink consumption or

¹⁷ The study identifies only one other category as having a positive cross-price elasticity for caloric sweetened beverage consumption: coffee/tea. But this estimate is statistically insignificant. All but one of the five remaining estimated cross-price elasticities with respect to caloric sweetened beverage prices are negative and significant. This means that the study's results imply that *only* diet beverages (among the authors' included beverage categories, at least) are complements to caloric sweetened beverages, with the other included beverages being substitutes.

¹⁸ The study is Ebbeling, Cara B., Henry A. Feldman, Stavroula K. Osganian, Virginia R. Chomitz, Sheila J. Ellenbogen, and David S. Ludwig (2006), "Effects of decreasing sugar-sweetened beverage consumption on body weight in adolescents: A randomized, controlled pilot study," *Pediatrics*, 117(3):673–680, March.

otherwise. The real questions (not addressed effectively by the USDA study) are 1) how large of a decrease in caloric sweetened beverage consumption would result from a tax?, 2) what products, if any, will consumers consume instead of caloric sweetened beverages?, 3) what healthful products will consumers give up in order to spend more of their income on taxed caloric sweetened beverages?, and 3) are the resulting shifts likely to have a significant—or even merely positive—affect on weight or other health effects?

What Smith, et al. mistakenly interpret as evidence that consumers will respond to a caloric sweetened beverage tax by reducing the consumption of *both* caloric sweetened beverages and diet drinks is actually an artifact of supplier decisions to price diet and non-diet versions of their drinks similarly. That business decision to price, for example, Coke and Diet Coke together does not turn the two products into complements, but can easily trick researchers using scanner data into that conclusion because prices of both move together. Because factors that change the price of Coke and Diet Coke are often similar, it should be no surprise that their prices and quantities sold in the marketplace move together. Regardless of these pricing decisions, consumers clearly view diet and non-diet beverages as substitutes. A study that finds differently is certainly in error due to the endogeneity bias discussed earlier.

In sum, the authors' finding that regular and diet beverages are complements is strong evidence against the plausibility of their estimates of price elasticities (and thus health effects).

9. Conclusion

The simulation exercise performed by Smith, et al. suffers from major methodological flaws and errors in reasoning. These flaws include extrapolating elasticity estimates well beyond the range covered in the underlying sample, a failure to include major substitute beverages such as alcoholic beverages and chocolate milk in the foundational demand system estimates, and applying average elasticities to all individuals in the sample despite the fact that price sensitivity may vary extensively in ways that correlate with body weights. All of these flaws have the potential to bias the estimates generated by the USDA simulation.

These flaws are particularly troubling when the USDA conclusions are compared to the conclusions of peer reviewed articles in the scientific literature. That literature, almost uniformly, finds no significantly negative relationship between caloric sweetened beverage prices and body weights using actual data, while the USDA simulation generates large body weight reductions. In light of the flaws outlined above, the USDA report does not provide a scientifically sound basis for policy decisions. Until these flaws can be remedied, the peer reviewed literature finding no systematic relationship between beverage prices and BMI provides the only reliable basis for evaluating policies aimed at increasing the price of caloric sweetened beverages.