Intermediate Economics
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Estimating the Potential Impact of a Sugar-Sweetened Beverage Excise Tax

Growing awareness of the link between sugar-sweetened beverages (SSBs) and America's obesity epidemic has led policy-makers to consider government interventions to reduce SSB consumption. A large body of scientific literature links consumption of SSBs to obesity, type 2 diabetes, and many adverse health outcomes.[1, 2, 3] Epidemic obesity levels cost the United States billions in medical care, estimated at $190 billion per year (one-fifth of U.S. national health expenditures).[4] A recent study estimates that SSBs account for 20 percent of the weight gain from 1977 to 2007 in the U.S. population.[5] Moreover, SSBs produce less satiety, leading to increases in total energy intake over the long term.[6]

In March of 2015, Rep. Rosa DeLauro introduced the SWEET Act, which would impose a federal excise tax on the sale of any specified sugar-sweetened beverage by the manufacturer, producer, or importer thereof at a rate of one cent per 4.2 grams (one teaspoon) of caloric sweetener. This memo estimates this tax for major categories of SSBs and the potential change in quantity of SSBs consumed per capita based on a range of elasticities of demand. Under a tax (if fully shifted to consumers) of one cent per teaspoon of sugar, individual per capita consumption could decline by 17 percent for non-diet carbonated soft drinks, 13 percent for fruit drinks, 16 percent for sports drinks, and 11 percent for energy drinks, using the mean elasticity of demand for each (Tables 3-6). Annual per capita consumption of the total SSBs analyzed in this memo could drop from 41.4 gallons to 34.6 gallons, a 17 percent reduction.

Background on SSB Taxes and the SWEET Act: Recent government interventions, such as in Berkeley, CA and the Navajo Nation, include taxing of SSBs to reduce consumption, curb obesity, and raise government revenue. These and other proposed Pigouvian taxes aim to address a negative externality of SSBs, which is that obesity increases health care costs for taxpayers who are third parties to the transactions between consumers and producers of SSBs.[7] Overweight and obese individuals do not bear the full cost of their increased weight, and a tax on SSBs attempts to modify SSB price to match true social cost. Most of the existing SSB excise tax proposals would impose a per-volume tax, usually a cent

per ounce of SSB; but Zhen and colleagues note that a calorie-based SSB tax would be more efficient than an ounce-based tax in achieving an added-sugar reduction target.[8] A tax aimed at curbing obesity should target the specific ingredient of concern (sugar), which varies widely in SSB products.

The SWEET Act employs the calorie-based approach, which may be more efficient than the ounce-based tax in reducing added-sugar consumption, but will result in different tax rates per SSB product. Most studies reviewed for this memo estimate the reduction in SSBs consumed based on the one-cent per ounce tax, instead of the one-cent per teaspoon of sugar tax. This memo estimates SWEET Act taxes per major type of SSB based on respective average sugar content for each (Table 1).

Estimating Change in Quantity due to the SWEET Act: The SWEET Act would impose a tax of one-cent per 4.2 grams of caloric sweetener contained in specified sugar-sweetened beverages.[9] Exceptions include milk, soy, rice, or similar plant-based milk substitute; 100% juice; infant formula; certain medical, nutritional, and electrolyte solutions; and alcohol—these beverages are excluded from this analysis. The SWEET Act would be adjusted for inflation in subsequent years and revenues raised from the tax would fund diet-related health research through the Prevention and Public Health Fund.

Defining SSB Quantity: Given that the SWEET Act imposes a tax based on sugar content and not SSB volume, this memo first identifies available data for SSB quantities consumed and associated sugar content. Andreyeva and colleagues combine industry beverage volume data with Census population estimates to calculate annual per capita consumption in 2009 of non-diet carbonated soft drinks (CSDs), fruit drinks (excluding 100% juice), sports drinks, energy drinks, as well as ready-to-drink (RTD) teas and coffees (due to inconsistent data on RTD teas and coffees, the two were not included in this memo, although their consumption quantities were relatively low compared to CSDs and the other SSBs).[10]

Sugar Content: The U.S. Department of Agriculture, National Nutrient Database provides data for grams of sugar per fluid ounce for many SSBs specified in the SWEET Act. Sugar content within SSB subcategories vary, so sugar content for this memo uses the mean of many products in each group for calculations (Table 1).

SSB Prices: Powell and colleagues provide the average price per ounce in 2012 dollars for many SSBs based on data collected from 2010 through 2012 in a national sample where 8th, 10th, and 12th grade public school students live.[11] For this memo, prices were adjusted for inflation to 2015 dollars.

Estimated Tax per SSB Category: The estimated tax per ounce of SSB is calculated by dividing the average grams of sugar per ounce of SSB by 4.2 grams to obtain the teaspoons of sugar per ounce and then multiplying that result by $.01, the SWEET Act tax.

Table 1: Beverage	**(A) Annual per capita consumption* (gallons)[12]**	**(B) Grams of Sugar per Oz[13]**	**(C) Teaspoons of Sugar (4.2 g) per Oz = (B)/4.2**	**(D) Original Price per Oz ($)[14]**	**(E) Tax per Oz = $.01 x (C)**	**(F) Tax = (E)/(D)**
CSDs (not diet)	31.2	3.05	0.73	$0.051	$0.007	14.2%
Fruit drinks (except 100% fruit juice)	5.2	3 (range: 3.7, 3.3, 2.38, 2.5)	0.71	$0.077	$0.007	9.3%
Sports drinks	3.8	1.7 (range: 1.6, 1.8)	0.40	$0.062	$0.004	6.5%
Energy drinks	1.2	3.4 (range: 3.2, 3.14, 3.8, 3.5)	0.81	$0.214	$0.008	3.8%

*Assuming per capita consumption has not changed from 2009.

Elasticities of Demand: Effectively addressing obesity, the SSB externality, depends on how much a price change reduces SSBs consumed, which partly depends on elasticity of demand. Powell and colleagues offer a systematic review of U.S. studies on the price elasticity of demand for SSBs, including subcategories for non-diet CSDs (mean E_d = -1.21), fruit drinks (mean E_d = -1.41), and sports drinks (mean E_d = -2.44).[15] Okrent and colleagues estimate the elasticity of demand for energy drinks (mean E_d = -2.84).[16] Tables 3 through 6 list the high and low elasticities of each. Price elasticities for SSB subcategories allow estimates for quantities consumed after the implementation of the SWEET Act tax. Given that a tax on sugar content would impact regular sodas and beverages but not diet versions, price elasticities of demand for SSBs excluding diet versions are used. A tax on higher sugar content beverages would potentially reduce SSB consumption more than a tax on both SSB and non-SSB drinks because, under a calorie-based tax, consumers could substitute to diet versions of drinks.[17]

Tax Incidence: The effectiveness of an SSB excise tax on reducing consumption also depends partly on the pass-through rate of the tax to consumers. This memo estimates the quantity of SSBs

consumed with three tax incidence scenarios where the SSB tax shifts fully to consumers, under shifts (0.5), and over shifts (1.5). Most literature reviewed for this memo assumes that an SSB tax is passed on one for one to consumers. The statutory burden of the SWEET Act tax would be imposed on producers: however, the extent to which the tax is passed through to consumers in higher prices, the economic tax incidence, depends on the relative elasticities of supply and demand in perfect competition. A working paper on Berkeley's SSB tax incidence estimates that retail prices rose by less than half of the amount of the tax, contrary to other empirical research findings that SSB excise taxes tend to be fully shifted, if not over shifted, to consumers, such as in Mexico, France, and Denmark. [18]

Taxes implemented at sub-levels of government, such as in Berkeley, CA, may be evaded through cross-border shopping outside of the taxed jurisdiction, whereas a national level SSB excise tax would be harder to avoid.[19] Given the ease in cross-border shopping with a city-level tax, some retailers may under shift the tax to consumers to avoid losing customers, resulting in less price change and SSB reduction than at the national level. Falbe notes that in monopolistic or oligopolistic markets, taxes may be overshifted; as other new jurisdictions impose SSB taxes, empirically studying prices and pass-through rates will help inform the effectiveness of SSB taxes.[20] Given the range of pass-through rates of SSB taxes reviewed in the literature, this memo estimates SSB consumption with the tax fully shifted to consumers, shifted 50 percent, and shifted 150 percent.

Impact on SSB Consumption: Using the data and assumptions above, Tables 2 through 6 display estimated annual per capita consumption in gallons of non-diet carbonated soft drinks, fruit drinks, sports drinks, and energy drinks with a one-cent tax on 4.2 grams of sugar. Quantities are estimated for a range of elasticities of demand and for the three scenarios of tax incidence mentioned above. Before the tax, Americans consumed 41.4 gallons annually per capita of the SSBs named above (31.2 gallons of CSDs, 5.2 gallons of fruit drinks, 3.8 gallons of sports drinks, 1.2 gallons of energy drinks). After the tax, using the mean elasticities of demand for each SSB type, and assuming the tax is fully shifted to consumers, the overall quantity of SSBs consumed would drop to 34.6 gallons per capita annually, a 17 percent reduction. Using the high demand elasticity, SSB consumption would drop by 29

percent to 29 gallons; using the low estimate of elasticity, SSB consumption would decline to 37.5 gallons, a 10 percent reduction. Table 2 shows the total estimated quantity consumed of the four SSBs analyzed under the SWEET Act tax for the three elasticities of demand and the three different incidences of taxation. (Tables 3 through 6 show the detailed price, tax, and new quantities for the four SSB groups.)

Table 2: Total SSBs	**Fully Shifted Tax**		**Under Shifted Tax (0.5)**		**Over Shifted Tax (1.5)**	
Q_o = 41.4 gal /person	**Q_n**	**% Reduction**	**Q_n**	**% Reduction**	**Q_n**	**% Reduction**
Mean E_d	34.6	17%	38.0	8%	31.2	25%
High E_d	29.3	29%	35.3	15%	23.2	44%
Low E_d	37.5	10%	39.5	5%	35.6	14%

Conclusion: A 17 percent reduction would represent a meaningful decline in SSB consumption; yet the full impact on obesity would depend on a number of other factors not examined in this memo, such as effects of an SSB tax on other beverages and foods. Finkelstein and colleagues examine substitutions and complementarity between SSBs and some food categories, including cookies and ice cream.[21] Their study finds that under an SSB tax, substitution to other beverages was minimal except for fruit juice; this is a concern with the SWEET Act, which exempts 100% fruit juice from the tax. Finkelstein, however, finds no substitution to sugary foods, and actually finds a decrease in ice cream and salty snacks, which both happen to be complements to SSBs.[22]

The eventual impact of the SWEET Act ranges from SSB consumption declining by 5 percent to 44 percent in this memo, depending on the elasticities of demand and the extent of tax pass-through. Recent media articles on nationally imposed SSB taxes report that the taxes are mostly passed on to consumers, which renders the lowest estimates in this memo less likely.[23] Opponents to SSB taxes point out the regressive nature of such taxes; proponents point out, however, the regressivity of negative health outcomes, which hurt low-income more than higher income groups. In fact, within the very group in Mexico affected most by diabetes and obesity, low income households, SSB consumption fell by 17 percent.[24] Many other factors must be analyzed to understand the larger impact of the SWEET Act, including: if SSB reduction would actually reduce obesity, if diabetes incidence would decline, how much medical care costs would shrink, and how much tax revenue would be generated. The impact on price and quantity, however, is an essential first step in analyzing the larger impact of the SWEET Act tax.

Tables and Figures

The tables below display estimated annual per capita consumption, in gallons, of various sugar-sweetened beverages with a 1-cent tax on 4.2 grams of sugar. Quantities are estimated for a range of elasticities of demand for carbonated soft drinks, fruit drinks, sports drinks, and energy drinks. Quantities are also estimated for three scenarios of tax incidence: one where the tax is fully shifted to consumers, second where the tax is under-shifted, and a third where the tax is over-shifted to consumers.

Calculation used for table:

$E_d = \frac{\%\Delta Q}{\%\Delta P} = \frac{\frac{\boldsymbol{Q_n} - Q_O}{Q_O}}{\frac{P_n - P_O}{P_O}}$ For example: E_d = -1.21 = $\frac{\frac{\boldsymbol{Q_n} - 31.2}{31.2}}{\frac{0.0583 - 0.051}{0.051}}$ $\boldsymbol{Q_n} = 31.2 + 31.2(-1.21\ x\ 0.142) = 25.8$

Table 3: Carbonated Soft Drinks (CSDs) in Gallons (128 oz = 1 gal)		Estimated Price (P_n) per oz and Quantity (Q_n), gal per capita		
		Tax Shifted to Consumers: P_o + tax	**Tax Undershifted**: P_o + .5(tax)	**Tax Overshifted**: P_o + 1.5(tax)
Q_o = 31.2 gal/person annually	P_o = \$0.051/oz	.051+.01*(4.2 g of sugar/oz) tax = 14.2%	.051*(1+0.5*0.142)	.051(1+1.5*.142)
Range of Elasticity of Demand		P_n = \$0.0583	P_n = \$0.05465	P_n = \$0.06195
Mean	-1.21	25.8	28.5	23.1
High	-2.26	21.1	26.2	16.1
Low	-0.71	28.0	29.6	26.4
Range of Elasticity of Demand		**% Change in Quantity = $(Q_n - Q_o)/Q_o$**		
Mean	-1.21	-17%	-9%	-26%
High	-2.26	-32%	-16%	-49%
Low	-0.71	-10%	-5%	-15%

Figure 1: Change in Quantity and Price for CSDs
E_d = -1.21; tax is shifted 50% to consumers

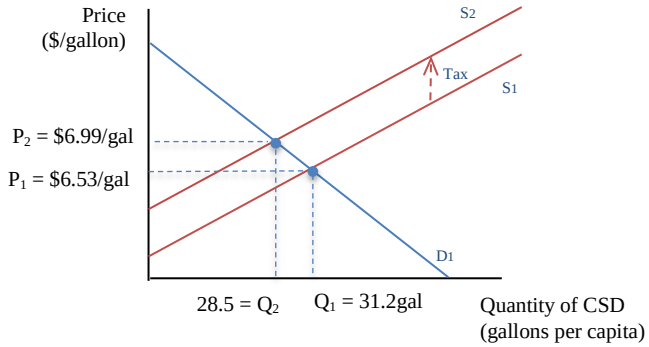

Table 4: Fruit Drinks		Estimated Price (P_n) per oz and Quantity (Q_n), gal per capita		
		Fully Shifted to Consumers: P_o + tax	**Tax Undershifted**: P_o + .5(tax)	**Tax Overshifted**: P_o + 1.5(tax)
Q_o = 5.2 gal/person annually	P_o = \$0.077/oz	.077+.01*(4.2 g of sugar/oz) tax = 9.3%	.077*(1+0.5*.093)	.077(1+1.5*.093)
Range of Elasticity of Demand		P_n = \$0.0841	P_n = \$0.0806	P_n = \$0.0877
Mean	-1.41	4.5	4.9	4.2
High	-1.91	4.3	4.7	3.8
Low	-0.69	4.9	5.0	4.7
Range of Elasticity of Demand		**% Change in Quantity = $(Q_n - Q_o)/Q_o$**		
Mean	-1.41	-13%	-7%	-20%
High	-1.91	-18%	-9%	-27%
Low	-0.69	-6%	-3%	-10%

Table 5: Sports Drinks		Estimated Price (P_n) per oz and Quantity (Q_n), gal per capita		
		Fully Shifted to Consumers: P_o + tax	**Tax Undershifted**: P_o + .5(tax)	**Tax Overshifted**: P_o + 1.5(tax)
Q_o = 3.8 gal/person annually	P_o = \$0.062/oz	.062+.01*(4.2 g of sugar/oz) tax = 6.5%	.062*(1+0.5*.065)	.062(1+1.5*.065)
Range of Elasticity of Demand		P_n = \$0.0660	P_n = \$0.0640	P_n = \$0.0681
Mean	-2.44	3.2	3.5	2.9
High	-3.87	2.8	3.3	2.4
Low	-1.01	3.5	3.7	3.4
Range of Elasticity of Demand		**% Change in Quantity = $(Q_n - Q_o)/Q_o$**		
Mean	-2.44	-16%	-8%	-24%
High	-3.87	-25%	-13%	-38%
Low	-1.01	-7%	-3%	-10%

Table 6: Energy Drinks		Estimated Price (P_n) per oz and Quantity (Q_n), gal per capita		
		Fully Shifted to Consumers: P_o + tax	**Tax Undershifted**: P_o + .5(tax)	**Tax Overshifted**: P_o + 1.5(tax)
Q_o = 1.2 gal/person annually	P_o = \$0.214/oz	.214+.01*(4.2 g of sugar/oz) tax = 3.8%	0.214*(1+0.5*.038)	.0214(1+.1.5*.038)
Range of Elasticity of Demand		P_n = \$0.2221	P_n = \$0.2181	P_n = \$0.2262
Mean	-2.84	1.07	1.14	1.01
High	-3.46	1.04	1.12	0.96
Low	-2.22	1.10	1.15	1.05
Range of Elasticity of Demand		**% Change in Quantity = $(Q_n - Q_o)/Q_o$**		
Mean	-2.84	-11%	-5%	-16%
High	-3.46	-13%	-7%	-20%
Low	-2.22	-8%	-4%	-13%

Notes

1. Lenny R. Vartanian et al., “Effects of soft drink consumption on nutrition and health: a systematic review and meta-analysis,” *American Journal of Public Health*. 97, no. 4 (2007): 667-675.

2. Adam M. Bernstein et al., “Soda consumption and the risk of stroke in men and women.” *American Journal of Clinical Nutrition* 95 (2012): 1190-1199.

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4. John Cawley and Chad Meyerhoefer, “The medical care costs of obesity: An instrumental variables approach,” *Journal of Health Economics* 31 (2012): 219-230.

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9. Sugar-Sweetened Beverages Tax Act of 2015, HR 1687, 114th Cong., 1st sess. (2015).

10. Tatiana Andreyeva et al., “Estimating the potential of taxes on sugar-sweetened beverages to reduce consumption and generate revenue,” *Preventive Medicine* 52 (2011): 413–416.

11. Lisa M. Powell et al., “Sugar-Sweetened Beverage Prices: Estimates from a National Sample of Food Outlets,” Chicago, IL: Bridging the Gap Program, Health Policy Center, Institute for Health Research

12. Andreyeva et al, “Estimating the potential of taxes on sugar-sweetened beverages to reduce consumption and generate revenue,” 415.

13. U.S. Department of Agriculture, Agricultural Research Service. National Nutrient Database, Basic Report, grams of sugar per 1 fl. oz.

14. Powell et al., “Sugar-Sweetened Beverage Prices: Estimates from a National Sample of Food Outlets,” 2012 price data adjusted for inflation to 2015 real dollars.

15. Lisa M. Powell et al., “Assessing the Potential Effectiveness of Food and Beverage Taxes and Subsidies for Improving Public Health: A Systematic Review of Prices, Demand and Body Weight Outcomes.” *Obesity Review* 14, no. 2 (2013): 110–128. doi:10.1111/obr.12002.

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17. Andreyeva, "Estimating the potential of taxes on sugar-sweetened beverages to reduce consumption and generate revenue." 414.

18. John Cawley and David Frisvold. "The Incidence of Taxes on Sugar-Sweetened Beverages: The Case of Berkeley, California." NBER Working Paper No. 21465 (2015).

19. Ibid., 23.

20. Jennifer Falbe et al., "Higher Retail Prices of Sugar-Sweetened Beverages 3 Months After Implementation of an Excise Tax in Berkeley, California," *American Journal of Public Health*, 105, No. 11 (November 2015): 2194 – 2201.

21. Eric A. Finkelstein et al., "Implications of a sugar-sweetened beverage (SSB) tax when substitutions to non-beverage items are considered," *Journal of Health Economics* 32 (2013): 219– 239.

22. Ibid., 223.

23. "Stopping slurping: Taxes on fizzy drinks seem to work as intended," *The Economist*, November 28, 2015.

24. Ibid.

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