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Estimating the potential of taxes on sugar-sweetened beverages to reduce consumption and generate revenue

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ABSTRACT

Objective: Beverage taxes came into light with increasing concerns about obesity, particularly among youth. Sugar-sweetened beverages have become a target of anti-obesity initiatives with increasing evidence of their link to obesity. Our paper offers a method for estimating revenues from an excise tax on sugar-sweetened beverages that governments of various levels could direct towards obesity prevention.

Model: We construct a model projecting beverage consumption and tax revenues based on best available data on regional beverage consumption, historic trends and recent estimates of the price elasticity of sugar-sweetened beverage demand.

Results: The public health impact of beverage taxes could be substantial. An estimated 24% reduction in sugar-sweetened beverage consumption from a penny-per-ounce sugar-sweetened beverage tax could reduce daily per capita caloric intake from sugar-sweetened beverages from the current 190–200 cal to 145–150 cal, if there is no substitution to other caloric beverages or food. A national penny-per-ounce tax on sugar-sweetened beverages could generate new tax revenue of $79 billion over 2010–2015.

Conclusion: A modest tax on sugar-sweetened beverages could both raise significant revenues and improve public health by reducing obesity. To the extent that at least some of the tax revenues get invested in obesity prevention programs, the public health benefits could be even more pronounced.

Introduction

The concept of food and beverage taxes came into light with increasing concerns about obesity, particularly among youth (Brownell et al., 2009; Brownell and Frieden, 2009). Sugar-sweetened beverages (SSBs; beverages with any added caloric sweetener) have become a target of anti-obesity initiatives along with increasing evidence of a link between their consumption and obesity (Vartanian et al., 2007). Increased SSB intake is associated with weight gain and obesity (Vartanian et al., 2007; Malik et al., 2006) that translates into health, economic and social costs (National Center for Health Statistics, 2008).

Changing relative food prices through tax or subsidy policies is likely an effective and (for taxes) inexpensive public health instrument to improve nutrition. Prior research shows that changes in food prices can improve diet and weight outcomes, particularly among youth, lower income populations, and those at risk for obesity (Powell and Chaloupka, 2009; Smith et al., 2010). Experience from tobacco tax regulation highlights the power of price changes to affect purchasing behavior and public health (Jha et al., 2006). In addition to direct price effects on purchases, tobacco taxes have generated significant revenues that some states have used to support comprehensive tobacco control programs that further reduced smoking (Chaloupka, 2010).

Economic studies have examined the impact of prices on beverage consumption, consistently finding that higher prices lead to reduced consumption (Powell and Chaloupka, 2009; Smith and al., 2010). A recent review predicted that a 10% price increase for soft drinks would reduce their consumption by 8%–10% (Andreyeva et al., 2010). Researchers also looked at the impact of existing taxes on beverages. As of 2009, 33 states applied a sales tax on soft drinks, but rates were small (range, 1%–7%) and designed to generate revenue rather than influence consumption (Chriqui et al., 2008). In the few studies to date, such small taxes have shown little to no effect on beverage consumption and obesity (Powell et al., 2009; Kim and Kawachi, 2006; Finkelstein et al., 2010; Sturm et al., 2010).

Another approach to beverage taxation is an excise tax (a fee per beverage unit) that has received increasing consideration among legislators, public health advocates and the media. The Congressional

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Budget Office (CBO) suggested a federal excise tax of ¢3/12 oz on SSBs to fund health care reform and estimated its revenue as $50 billion over 2009–2018 (Congressional Budget Office, 2008). Several states and cities have attempted to institute an excise SSB tax, unsuccessfully so far. The most common proposal is a penny per ounce tax on beverages with added sweeteners (Brownell et al., 2009; Brownell and Frieden, 2009). Several states already impose small excises, license or privilege fees on beverage bottles, syrup, powder/mix that are paid by wholesalers, distributors, retailers and/or manufacturers (ImpacTEEN, 2009).

Accurate estimations of revenue from beverage taxes are important to public officials in budget planning, but also challenging methodologically. Deriving accurate estimates must include best possible precision on regional variation in beverage consumption, the expected impact on consumption, and historic trends. The aim of this paper is to offer a method for estimating revenues from an excise tax on SSBs and diet varieties that governments of various levels could expect immediately and in the future.

Methods

Consumption

State- and city-level consumption data are not available and should be estimated from national or regional data. We used gallonage (volume) industry data on 2008 regional consumption of carbonated soft drinks (CSDs), fruit beverages (not including 100% fruit juice) and ready-to-drink (RTD) teas. Data for sports drinks, flavored/enhanced waters, energy drinks, and RTD coffees was from the industry 2008 U.S. total sales. We determined beverage consumption across states by their share in the U.S. population adjusting for variability in per capita beverage consumption across seven regions for CSDs and fruit drinks (Northeast, East Central, Pacific, South, Southwest, West, and West Central) and four regions for RTD teas (Northeast, West, Midwest, and South). This approach does not account for within region variation, but it is still a notable improvement assuming constant per capita beverage consumption.

Using data on regional markets for CSDs, fruit drinks and RTD teas, we estimated adjustment coefficients for states located in respective regions. The share of diet varieties in CSDs in 2008 was about 31% for the U.S., but varied across regions (Beverage Marketing Corporation, 2009a). We assumed the same share of diet varieties in RTD teas and only regular varieties for other beverages. Projecting consumption patterns into 2015, we increased diet share in CSDs and RTD teas by 0.5 percentage points annually.

In projecting future SSB consumption, we incorporated historic trends on growth for some and declines in consumption of other beverages. We used average rates of change over 2000–2009 for CSDs, 2005–2009 for fruit beverages, 2006–2009 for sports drinks, 2007–2009 for RTD teas, 2008–2009 for flavored/enhanced water, 2008–2009 for energy drinks, and 2007–2009 for RTD coffee (Beverage Marketing Corporation, 2009a, 2009b, 2009c; Beverage World, 2010; Beverage World, 2009; Beverage World, 2008; Beverage World, 2007). We chose these periods based on available data and perceived stability of trends. For example, new beverages such as energy drinks had growth rates of 50%–70% in 2001–2006, which declined to 5.4% in 2008 and 0.2% in 2009. The initial dramatic growth for a new product is unlikely to continue more than several years. We assumed that CSDs would decline in volume by 0.7% annually over 2010–2015. CSDs experienced more dramatic 2%–3% annual declines in consumption in more recent years, but these patterns may be temporary.

Population

We used U.S. Census population projections from 2007 to 2015 (United States Census Bureau, 2009). We assumed that beverage purchases would be subject to an excise tax at the same rate for all consumers. Participants in the Supplemental Nutritional Assistance Program (SNAP) are exempt from paying a sales tax when using SNAP benefits, but we do not anticipate this exemption with an excise tax. Taxation of SSB purchases with SNAP benefits would be important given that adult consumers among SNAP participants are more likely to choose sugar-sweetened varieties of CSDs (63% vs. 50%) and less likely to choose diet beverages (10% vs. 22%) than higher-income nonparticipants (U.S. Department of Agriculture, 2008).

Pricing

We used estimates of the price elasticity of demand (a percentage change in purchases with a 1% change in prices) from recent published studies. An alternative approach would be to derive elasticity parameters in our own modeling exercise (Fletcher et al., 2010a, 2010b). The scenario of taxing SSBs and diet varieties assumed the price elasticity at −0.8, as suggested in a review of 14 studies (Andreyeva et al., 2010). The SSB model, accounting for substitution to other beverages, used a higher price elasticity of −1.2 (Smith et al., 2010). Estimates in the same range were suggested in other recent research (Finkelstein et al., 2010). We assessed beverage prices at a variety of vendors in spring 2009 and used the mid-point range for a combination of sale and regular prices and types of stores. We assumed no regional price variation.

Producers and retailers are assumed to pass the tax fully on consumers. It is plausible that the tax is over- or under-shifted depending on strategic behavior among manufacturers and/or retailers and the relative elasticities of supply and demand. Over-shifting implies that a tax-induced price increase is greater than the actual tax leading to a larger drop in consumption and tax revenues compared to a fully-passed tax. Under-shifting is the opposite effect of a lower price increase, a lower reduction in consumption and higher tax revenue. Prior evidence on sales taxes and especially excise alcohol taxes indicate over-shifting (Besley and Rosen, 1999; Kenkel, 2005; Young and Bielínska-Kwapisz, 2002). Evidence for cigarette excise taxes suggests either a full pass through or some over-shifting as producers in a highly concentrated market may use this as an opportunity for a coordinated price increase that raises prices by the tax or more (World Health Organization, 2010).

In projecting consumption and revenue effects of an SSB tax we assumed that prices of diet varieties remain unchanged. In practice, bottlers and/or retailers could set the same or similar prices on both types of beverages or use other strategies to counteract the tax. Spreading an SSB tax on all beverages would increase tax revenues from a larger taxable base but mitigate a beneficial public health effect. Such strategic manipulations were beyond the scope of our analysis. We adjusted prices for inflation and held them unchanged. We further assumed a constant nominal value of the tax that meant a somewhat smaller impact of the tax in future years. Experience with state excise alcohol taxes suggests that lack of the inflation anchor is common, which could erode their power over time (Marin Institute, 2010).

Results

In 2009, U.S. per capita consumption of all non-alcoholic beverages (but milk) was 94.2 gal/year, including 45.0 gal of SSBs (Table 1). This translates into an average daily SSB intake of 15.8 oz or about 190 cal. Studies using dietary recall data reported on average 190 cal consumed daily from SSBs (Nielsen and Popkin, 2004). The highest per capita consumption among all beverages was for regular CSDs (31.2 gal) followed by bottled water (27.5 gal) and diet CSDs (14.2 gal). CSDs dominated the beverage market with other beverages (excluding bottled water) accounting for 21.3 gal. Energy drinks and RTD coffee had the lowest per capita consumption, but their volume and market share were rapidly increasing.

Using historic trends for various beverage categories we projected beverage consumption through 2015 and estimated a reduction in per capita SSB consumption from 45 gal in 2009 to 40 gal in 2015. This ongoing trend may reduce average SSB daily intake by about 2 oz (or 22 cal). Some beverages, such as bottled water, were expected to grow in total sales slower than population growth (about 1% (United States Census Bureau, 2009)). Trends for beverages like fruit drinks suggested a continuing reduction in future total sales and per capita consumption. Only three beverage categories seem to be on the path to exceed rates of population growth with higher per capita consumption in the future: energy drinks, RTD tea and coffee. Finally, diet CSDs and RTD teas were projected to grow by 2% in per capita consumption between 2009 and 2015.

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Table 1
U.S. liquid refreshment beverage market, 2009.
Sources: Authors' calculations based on industry data (Beverage World, 2010) and population estimates (United States Census Bureau, 2009).

Beverage	Annual per capita consumption* based on volume data (gal)	Annual total volume (million gal)
Carbonated soft drinks (CSDs), regular varieties	31.2	9555.1
CSDs, diet varieties	14.2	4364.2
Fruit drinks (excluding 100% fruit juice)	5.2	1589.5
100% fruit juice	6.5	1989.7
Sports drinks	3.8	1157.8
Ready-to-drink (RTD) teas, regular varieties	2.0	618.8
RTD teas, diet varieties[b]	0.9	282.6
Flavored/enhanced water	1.5	460.0
Energy drinks	1.2	354.5
RTD coffees	0.2	51.5
Bottled water	27.5	8435.3
Total sugar-sweetened beverages[c]	45.0	13,787.2
Total beverages	94.2	28,859.0

[a]The share of diet varieties in 2009 CSD consumption is assumed to increase from its 2008 level by 0.5 percentage points.
[b]The share of diet RTDs is assumed the same as for CSDs.
[c]SSBs include beverages with added sweeteners such as regular varieties of CSDs, fruit drinks (excluding 100% fruit juice), sports drinks, regular varieties of RTD teas, flavored/enhanced water, energy drinks, RTD coffee. Sports drinks, RTD coffee, energy drinks, flavored water are assumed to be all of regular varieties.

We estimated substantial changes in beverage consumption from a national penny-per-ounce tax on SSBs and diet varieties (Table 2). We used this tax amount as it has been suggested by prominent public health experts (Brownell et al., 2009; Brownell and Frieden, 2009) and considered by legislators. Our model, however, allows a range of taxes from ¢0.01/oz to ¢2/oz, and these estimates will be made available in an online calculator. Note that an average SSB price used in the estimation is slightly above ¢5/oz, so that ¢1/oz tax is about a 20% price increase. The SSB model predicts a reduction in consumption of regular CSDs by 26.7% with annual per capita SSB consumption falling to 34 gal. All SSBs are predicted to decline by 24%. Consumption of more expensive per-ounce beverages such as energy drinks falls by a smaller percentage as a per-ounce tax results in a smaller relative increase in the price of these beverages. The model that includes a tax on diet varieties predicts a 16.3% reduction in consumption of all beverages.

Table 3 presents estimates of potential tax revenues from a national penny-per-ounce tax on SSBs and SSB/diet beverages. The revenue generating potential of a nationwide penny-per-ounce SSB tax is considerable and could secure a substantial stream of new revenue of $78.9 billion over 2010–2015. As an SSB tax would exempt diet beverages and encourage consumers to substitute SSBs with untaxed beverages, it would generate less revenue than a tax on diet beverages and SSBs. At the national level, it is predicted to generate almost $118 billion over 2010–2015.

Similar to a nationwide excise tax, there is a substantial revenue generating potential of SSB taxes for states and cities, especially in the West Central and Southern regions where per capita beverage consumption is particularly high (Table 4). For example, if there was a penny-per-ounce SSB tax in 2010, Florida could have raised $899 million in new revenue in that year alone, Texas almost $1.1 billion, California over $1.1 billion, and New York $806 million. Projections of city-level beverage taxes suggest their substantial revenue potential. For example, New York City could have generated about $348 million from a penny-per-ounce tax on SSBs in 2010, Chicago $133 million and Philadelphia almost $59 million.

Discussion

We developed a method to estimate revenues from an excise tax on SSBs and diet varieties. Such taxes could help the nation and many states address serious budget deficits, both by generating considerable revenue and potentially decreasing health care costs from declining SSB consumption. Our model predicts that a national penny-per-ounce tax on SSBs could generate new tax revenue of $79 billion over 2010–2015. When applied to SSBs and diet varieties nationwide, this tax could bring $118 billion over 2010–2015. These projections are based on best available data on regional per capita beverage consumption, historic trends and recent estimates of the price elasticity of demand. Additional model modifications could include regional or state-level price data, incorporate cross-price elasticities and make alternative assumptions about the price elasticity and the rate that the tax gets passed on consumers. Our revenue estimates are likely to be conservative as we do not account for new beverages that the industry will likely introduce to offset declines in traditional beverage categories.

Table 2
Estimated percentage reduction in U.S. total consumption, 2010.
Source: Authors' calculations.

Beverage	Tax of beverage (¢1/oz)	
	SSBs taxed, %	SSBs and diet varieties taxed, %
CSDs, regular varieties	26.7	17.8
CSDs, diet varieties	0	17.8
Fruit drinks, excluding 100% fruit juice	17.1	11.4
Sports drinks	24.0	16.0
RTD teas, regular varieties	13.3	8.9
RTD teas, diet varieties	0	8.9
Flavored/enhanced water	21.8	14.6
Energy drinks	6.9	4.6
RTD coffees	6.0	4.0
Total	24.0	16.3

Table 3
Estimated beverage tax revenues, US total million dollars.
Sources: Authors' calculations.

Beverage	Tax of beverage (¢1/oz)			
	SSBs taxed		SSBs and diet varieties taxed	
	2010	2010–2015	2010	2010–2015
CSDs, regular varieties	8831	52,272	9901	58,085
CSDs, diet varieties	0	0	4646	28,862
Fruit drinks, excluding 100% fruit juice	1631	9155	1743	9740
Sports drinks	1115	6653	1232	7297
RTD teas, regular varieties	722	4992	759	5229
RTD teas, diet varieties	0	0	355	2,598
Flavored/enhanced water	451	2610	493	2834
Energy drinks	435	2823	446	2888
RTD coffees	65	445	66	454
Total	13,250	78,950	19,642	117,986

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Table 4
State projections of tax revenues for SSB taxes, 2010. Million dollars.
Sources: Authors' calculations.

State	SSB tax of ¢1/oz	State	SSB tax of ¢1/oz
US total	13,250	MO	336
AL	215	MT	40
AK	20	NE	100
AZ	288	NV	111
AR	134	NH	57
CA	1114	NJ	374
CO	199	NM	86
CT	148	NY	806
DE	37	NC	437
DC	22	ND	36
FL	899	OH	548
GA	448	OK	154
HI	39	OR	111
ID	62	PA	521
IL	612	RI	46
IN	303	SC	208
IA	171	SD	45
KS	159	TN	291
KY	202	TX	1059
LA	215	UT	107
ME	56	VT	27
MD	245	VA	374
MA	276	WA	191
MI	494	WV	86
MN	308	WI	271
MS	139	WY	21

These introductions are likely to draw from existing categories with little impact on total SSB/diet beverage volume.

The public health impact of beverage taxes could be substantial. An estimated 24% reduction in SSB consumption from a penny-per-ounce SSB tax could reduce daily per capita caloric intake from SSBs from the current 190–200 cal to 145–150 cal. Assuming that it takes a reduction of 3500 cal to reduce body weight by a pound (Centers for Disease Control and Prevention, 2010), a daily deficit of 50 cal could translate into significant losses in average body weight—up to 5 lb/year. This is certainly an upper bound given potential substitution to other caloric beverages and foods. Reliable estimates of the cross-price elasticities necessary to quantify the extent of possible substitution and the net impact on caloric intake are not available.

The public health impact of SSB taxes could be particularly important in populations at greater risk for obesity such as children and low-income groups where SSB consumption is high. Recent estimates indicate that 12 to 19 year olds consume 356 cal from SSBs daily (Wang et al., 2008), so 85 excessive calories daily (24%) could be eliminated by an SSB tax if there is no substitution to caloric beverages or food. Youth, lower-income groups, and those most at risk for obesity are likely to be more responsive to prices (Powell and Chaloupka, 2009).

A modest tax on SSBs can both raise significant revenues and reduce SSB consumption, which should help reduce obesity (World Health Organization, 2010) and improve public health. To the extent that at least some of the tax revenues get invested in obesity prevention programs, public health benefits could be even more pronounced.

Conflict of interest statement

The authors have no conflict of interest in regards to this paper.

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