Food Taxes and Subsidies: Evidence and Policies for Obesity Prevention

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1. Introduction

Food taxes or subsidies are increasingly being proposed and assessed as potential policy instruments to address the obesity epidemic (Brownell et al. 2009a, 2009b; Powell and Chaloupka 2009). The idea behind such policies is to increase the relative price of consuming unhealthy energy-dense foods versus more healthy less energy-dense foods in order to shift consumption patterns toward more healthful diets that would translate into lower weight. The marked increases in obesity observed over the past few decades have been related to changes in the relative costs of food and physical activity as a result of technological improvements such that individuals' behaviors have correspondingly shifted toward more energy intake and less activity (Lakdawalla and Philipson 2002; Phillipson and Posner 2003). The declining real price of food and the relatively low cost and greater convenience of energy-dense foods, in particular, are hypothesized as key contributors to overweight based on substantial reductions in the cost of consuming a calorie (Cutler, Glaeser, and Shapiro 2003; Drewnowski and Darmon 2005; Bleich et al. 2008).

The extent to which tax and or subsidy policy instruments can successfully shift consumption away from energy-dense unhealthy products towards more optimal less-dense healthful products and, in turn, improve weight outcomes, depends on a number of factors. First, food consumption itself must be price sensitive. A number of controlled experimental studies have shown that reductions in prices have resulted in significant increases in healthy food purchases for fruits, vegetables, and low-fat items (Jeffery et al. 1994; French et al. 1997a, 1997b, 2001; Horgen and Brownell 2002; Epstein et al. 2006, 2007). However, for controlled field experiments, external validity may be low and overall caloric intake may not change substantially if individuals compensate in uncontrolled environments. A vast literature has examined the price elasticity (percentage change in consumption resulting from a one percent change in price) of food and beverage demand. A recent review of a range of studies including those based on large survey data sets shows that food consumption or expenditure is generally price sensitive with average price elasticities generally less than one: for example, -0.78 for soda; -0.35 for sweets/sugars; -0.77 for juice; -0.55 for fats/oils; -0.70 for fruit; -0.59 for vegetables; and, -0.81 for food away from home (Andreyeva et al. 2010).

Second, beyond the price sensitivity of demand, pricing interventions must reduce net calorie consumption in order for weight outcomes to improve. Even with significant price elasticities of demand, taxes, for example, may not translate into significant overall changes in diet or weight if individuals substitute toward alternate lower priced energy-dense products. For total calories to fall, individuals must not substitute equally energy-dense non-taxed food items for taxed items, nor in the case of a subsidy should they increase overall total calories.

In this chapter, we begin with a brief description of the way in which food, beverage and restaurant consumption products are currently taxed and subsidized in the U.S. We then review the empirical evidence on the direct effect of food, beverage and restaurant prices and taxes on individuals' weight outcomes to assess the potential effectiveness of using tax and subsidy pricing interventions to reduce obesity. Finally, we discuss important policy design considerations related to implementing pricing policy interventions aimed at obesity prevention.

2. Taxes and Subsidies in the United States

2.1. Understanding the current system of taxation in the United States

Currently, in the United States, there is no federal tax on foods and beverages as in other countries such as Canada and Australia (Caraher and Cowburn 2005; Leicester and Windmeijer

2004). Thus, any taxation of unhealthy foods and beverages such as candy and sugar sweetened beverages is the responsibility of state and local governments. As a result, a patchwork system of taxation exists whereby certain products are taxed in some but not all states and localities, and where the size of the taxes that do exist vary by state and locality (Jacobson and Brownell 2000; Chriqui et al. 2008).

Most food and beverage items are generally exempted from state sales taxes or are included in a general definition of food products that, when taxed, are taxed at a markedly lower rate than sales taxes applied to other goods and services. For example, according to our data compiled under the Robert Wood Johnson-supported Bridging the Gap Program as of January 1, 2009, the average state (across the 50 states plus the District of Columbia) sales tax on food products generally was 1.02 percent; whereas, the average state sales tax on non-food items was 4.91 percent (see Table 1). However, among states that actually impose sales taxes, the average rates are somewhat higher—only 14 states specifically tax food products generally (with an average sales tax rate of 3.69%) as compared to 46 states with a general sales tax (with an average rate of 5.45%).

The distinction between general and food sales taxes is important for understanding how unhealthy foods and beverages such as fast food purchases, candy, and sodas are currently taxed in the United States. For the most part, any food purchased in a restaurant, including both fast food restaurants and full-service or sit-down establishments, follow the general state sales tax scheme. The few exceptions are in the District of Columbia, New Hampshire and Vermont—each applies a restaurant-specific tax that is higher than the state's general sales tax. As of the beginning of 2009, the average state sales tax on restaurant (including fast food) sales was 5.21 percent across all states and was 5.66 percent in the 47 states with such a tax (Table 1).

All other food and beverage products either are not taxed, are taxed as part of the definition of "food," or, depending on the item, taxed at a higher rate than the general food tax but lower than the state sales tax (Chriqui et al. 2008). As Table 1 illustrates, states currently tax items such as potato chips/pretzels and baked goods at the same rate as food products generally (i.e., 1.02%). Taxes on candy and sodas, however, tend to be taxed at a higher rate than food products generally and, therefore, are considered "disfavored" relative to other food products (Chriqui et al. 2008; Stone et al. 2001). In fact, as of January 1, 2009, 33 states applied a sales tax to sodas sold through grocery stores and 29 states applied such a tax to candy sales as compared to only 14 states that taxed food items generally. The average state sales tax for candy was 2.76 percent across all states and 4.85 percent in the 29 states that imposed such a tax. The sales tax on sodas was somewhat higher—3.36 percent across all states and 5.20 percent in the 33 states with a soda sales tax. Notably, none of the revenues generated from these taxes are dedicated to obesity prevention efforts or programs.

Insert Table 1 about here

2.2. Trends in Food and Beverage Taxation

With the exception of the general state sales tax and the tax on fast food restaurant items, state sales taxes on foods and sodas have declined or remained fairly stable between 1997 and 2009 (see Figure 1). The largest percentage declines over this time period have been for chips/pretzels and baked goods. Specifically, the average general food tax across all states declined from 1.70 percent to 1.02 percent while the average sales tax on chips/pretzels and baked goods declined from 1.85 percent and 1.93 percent, respectively, to 1.02 percent (same as

the food tax). The average state sales taxes on candy and sodas, however, declined by less than ½ of a percentage point over this time period—changing from 3.83 to 3.36 percent for soda and from 3.35 to 2.76 percent for candy (which was equivalent to a 12% and 17% decrease in the tax rates for these items, respectively). In contrast, the sales tax applied to fast food restaurant sales increased slightly from 4.99 percent in 1997 to 5.22 percent in 2009.

Insert Figure 1 about here

2.3. Other Types of Taxes on Foods and Beverages

Besides sales taxes applicable to foods and beverages sold through grocery stores, a number of states also impose a sales tax to items sold through vending machines. In fact, in all cases, more states tax items through vending machines than through grocery stores and the tax rates are higher for vending sales than grocery sales (Chriqui et al. 2008). For example, 29 states tax candy sold through grocery stores at an average of 4.85% but 37 states tax candy sold through vending machines at an average of 5.14%. Similarly, while 33 states tax soda sold through grocery stores at an average of 5.20%, 39 states tax soda sold through vending machines at an average of 5.26%.

At the same time, in addition to sales taxes, seven states—Alabama, Arkansas, Rhode Island, Tennessee, Virginia, Washington, and West Virginia—currently impose other types of taxes or levy fees for the sale of soda (Chaloupka, Powell, and Chriqui 2009; Chriqui et al. 2008). These additional taxes generally apply to bottles, syrups, and/or powders/mixes and are targeted at various levels of the distribution chain including wholesalers, bottlers, manufacturers, and distributors; however, none of the revenue generated from these additional taxes/fees is currently dedicated to obesity prevention programming. With the exception of the license fees and taxes imposed on manufacturers, wholesalers, and/or retailers in Alabama (Ala. Code §§ 40-12-65, -69, -70 (2010)), most of these additional taxes or levies are based on volume of soda (typically in gallons) (Chriqui et al. 2008). For example, as of January 1, 2009, an excise tax is placed upon manufacturers, distributors, wholesalers, and retailers in the amount of one-cent per half liter or fraction of soda placed in bottles. In Washington state, an excise tax of $1 per gallon of soda syrup is imposed upon wholesalers and retailers of soda syrup (Wash. Rev. Code Ann. § 82.64.020 (2010)). In Rhode Island, an excise tax of 4 cents per case of 24, 12-ounce soda cans is placed upon manufacturers (R.I. Gen. Laws § 44-44-3 (2010)).

2.4. Food and Beverage Subsidies Directed at Consumers in the U.S.

Food and or beverage subsidies have not traditionally been targeted at consumers with the aim of shifting consumption patterns and preventing obesity. Rather, food in the U.S. is subsidized to help alleviate food insecurity for low-income individuals and families through a number of programs such as Food Stamps; the Women, Infant and Children (WIC) Nutrition Program; the Child and Adult Care Food Program; and the National School Lunch and Breakfast Programs. Subsidies directed at the consumer do not generally exist for specific food items; although some benefits such as WIC can only be used for certain foods and others are delivered through the provision of regulated foods such as school breakfasts and lunches. However, the USDA undertook a “Healthy Purchase” pilot program in California that targeted subsidies within the food stamp program such that for each dollar of food stamps spent on fresh produce, participants were subsidized a portion of the cost (Guthrie et al. 2007). Most recently, more permanent changes were made within the WIC program with the addition of monthly cash-value

vouchers specifically for fruits and vegetables in the amount of $10 for fully breastfeeding women, $8 for non-breastfeeding women and $6 for children (Oliveira and Frazao 2009). The scientific and nutrition communities also recently issued recommendations to improve the nutritional quality of USDA-subsidized school meals by including specific nutrient targets for calories, fats, cholesterol, protein, vitamins, and minerals; and recommending that school meals align with the 2005 Dietary Guidelines for Americans with the goal of increasing the amount of fruits, vegetables and whole grains offered as part of the school meals (Institute of Medicine 2009b). Likewise, as part of the congressionally-mandated wellness policy required of all school districts in the U.S. participating in the federal school meal programs (P.L. 108-265, Section 204), some districts have taken specific steps to require a minimum number of fruits and vegetables, whole grains, and skim/low-fat milk daily as part of the school meal offerings (Chriqui et al. 2009).

3. Empirical Evidence on Prices and Weight Outcomes

We conducted a literature search in November of 2009 to identify peer-reviewed articles published in English from 1990 through 2009. Studies were identified from the following data bases: Medline, PubMed, Econlit, and PAIS. Fifteen search combinations were used which included the terms Obesity, Body Mass Index (BMI) and BMI each in combination with the terms Price, Prices, Tax, Taxation and Subsidy. Studies also were considered based on the authors' knowledge of the existing literature. The articles were reviewed by two individuals to assess their appropriateness for inclusion in our review which was based on the criteria that the paper needed to provide published or in press original quantitative empirical evidence on the relationship between food prices (or taxes or subsidies) and body weight outcome measures using U.S. data. A total of 18 articles described in Table 1 met our inclusion criteria and were reviewed as part of our evidence base on the potential effectiveness of using tax or subsidy pricing instruments to improve weight outcomes measured by BMI (weight in kilograms divided by height in meters squared) and obesity prevalence (BMI $\geq$30 for adults and in the case of children as defined by age- and gender-specific BMI $\geq 95^{th}$ percentile).

Table 2 summarizes the 18 studies that examine the relationship between food, beverage and restaurant prices or taxes and weight outcomes. Eleven of the studies are cross-sectional and seven use longitudinal estimation methods to control for unobserved individual-level heterogeneity. One study examines aggregate state-level obesity prevalence rates rather than individual-level weight outcomes. This literature is still not vast but there has been a proliferation of studies published or in press over the past year, doubling the available evidence reviewed just over a year ago (Powell and Chaloupka 2009). Note that the table reports price evidence for relevant products that are candidates for pricing policies, including fast food, sugar, soda and high calorie products as possible items for taxation and fruits and vegetables as candidates for subsidies. We do not report on price effects for items such as overall food at home price indices and full service restaurant prices since such broad measures are not appropriate candidates for pricing policy interventions aimed at obesity prevention.

Insert Table 2 about here

3.1. Empirical Evidence for Taxation

We begin by reporting on the evidence on the extent to which taxes on energy-dense high calorie foods and/or beverages may translate into weight outcomes. As shown in Table 1, a

number of studies, particularly those on adolescent weight, have examined the association between fast food prices and BMI and obesity. All of these studies used the American Chamber of Commerce Researchers' Association (ACCRA) price data as their source for fast food prices. The fast food price evidence available for adults is limited, based on cross-sectional models only, and the findings are mixed. Chou, Grossman and Saffer (2004) undertook cross-sectional analyses using data from the Centers for Disease Control and Prevention's Behavioral Risk Factor Surveillance System (BRFSS) and found adult BMI to be statistically significantly negatively related to fast food restaurant prices (elasticity of -0.05) and obesity prevalence was found to be negatively but not statistically significantly related to fast food prices (elasticity of -0.65). In contrast, however, Beydoun, Powell and Wang (2008), using older data from the 1994-96 Continuing Survey of Food Intakes by Individuals (CSFII), did not find a statistically significant negative relationship between fast food prices and BMI or obesity prevalence.

Higher fast food prices have been related to lower BMI and obesity among adolescents in a number of studies. Estimating cross-sectional models using the 1997-1999 waves of the National Longitudinal Survey of Youth 1997 (NLSY97), Chou, Rashad, Grossman (2008) found higher fast food prices to be significantly associated with lower youth BMI and in subsamples it was significant for female but not male youths; however, the negative association found with obesity prevalence was not statistically significant. Examining cross-sectional data from 1997 through 2003 from the University of Michigan's Monitoring the Future (MTF) study on 8th and 10th grade adolescents, Powell et al. (2007) found the price of fast food to be weakly statistically significantly related to lower BMI levels among youths (elasticity -0.04) and statistically significantly related to a lower probability of overweight (elasticity of -0.59). In a subsequent study using the MTF youth data, Auld and Powell (2009) used quantile regression analyses to assess the differential relationship between food prices and BMI across the BMI distribution. The BMI regression results showed that fast food prices were associated with BMI but the effects were small: the fast food price elasticity for BMI was -0.03. The results from the quantile regressions showed that the fast food price effects at the higher quantiles were three to four times greater than across the distribution as a whole. For example for male and female adolescents, the BMI fast food price elasticities were -0.10 and -0.11, respectively, at the 90th BMI quantile, suggesting that taxes would have larger effects for adolescents at risk of obesity.

Most recently, Powell (2009) found that estimates based on longitudinal individual-level fixed effects models confirmed previous cross-sectional findings that the price of fast food had a statistically significant effect on teen BMI. A one dollar increase in the price of fast food was estimated to reduce adolescent BMI by 0.65 units, corresponding to a fast food price elasticity of -0.08. Estimates from the individual-fixed effects model suggested that the cross-sectional model over-estimated the price of fast food BMI effect by about 25%. This study found the weight of teens in low- to middle-socioeconomic status families to be most sensitive to fast food prices. Teens with low-educated mothers (high school or less) were found to be more price elastic (BMI fast food price elasticity of -0.13) than those with mothers with college education. Estimates by income tertiles revealed significant price sensitivity for teens living in middle-income households with a BMI fast food price elasticity of -0.31.

In studies that included younger children there was generally no evidence of significant fast food price effects on weight outcomes. Using a random-effects estimation model, Powell and Bao (2009) found that fast food prices were not statistically significantly related to BMI in the full sample of children aged 6-18 but were weakly negatively associated with BMI among adolescents with an estimated price elasticity of -0.12 (Powell and Bao 2009). Similarly, Sturm

and Datar (2005) did not find any evidence that fast food prices were statistically significantly related to young children's weight outcomes. Powell and Chaloupka (2009) also found that fast food prices were not statistically significantly related to children's weight outcomes, in either the cross-sectional or longitudinal fixed effects models for the full sample. However, the cross-sectional results suggested that higher fast food prices were associated with lower BMI among low-income children (price elasticity of -0.77), but the estimated effect for the low-income sample from the longitudinal model was not statistically significant.

Two studies have focused on sugar prices and adult weight drawing on the BRFSS data merged with county-level price data obtained from the U.S. Department of Agriculture (USDA). Based on a rational addiction model, Miljkovic, Nganje and de Chastenet (2008) found that individuals' weight was significantly negatively associated with the current price of sweet foods but a future increase in the price of sweet foods was not associated with a current reduction in weight. In a subsequent study, Miljkovic and Nganje (2008) found that a one dollar increase in the current price of sugar was associated with a 0.20 and 0.33 percentage point reduction in the probability of overweight and obesity, respectively. Based on the summary statistics provided in the paper, the marginal effects correspond to a current price of sugar elasticity of -0.20 for overweight and -0.81 for obesity. In addition, statistically significant large associations were found between the historical price of sugar and overweight supporting the myopic model of addictive behavior. Overall, these results suggest that taxing high-sugar food items may have long-run significant effects on weight outcomes. Another recent study also suggests the potential for substantial long-run effects on BMI from taxes applied to high calorie products. Drawing on data from the Health Retirement Survey (HRS), Goldman, Lakdawalla, and Zheng (in press) estimated the short-term (2 year) effect of the price of calories on body weight to be -0.063, but estimated that a permanent 10 percent increase in price per calorie would lead to a long-run (30 year) 4.2 percent reduction in BMI.

Finally, several studies have drawn on existing state-level food and beverage sales taxes to examine the tax sensitivity of weight, mostly with a focus on soda taxes. Overall, the results show that at the current tax levels there is minimal evidence of an effect on weight. A study using aggregated individual-level data at the state level from the BRFSS and state soda and snack sales taxes by Kim and Kawachi (2006) found no statistically significant differences in obesity prevalence between states without taxes and those with taxes or those with at least a 5% tax. They found weak statistical evidence that, compared to states with taxes, states that had repealed a specific soft drink or snack food tax were thirteen times more likely to have had a high ($\geq$ 75 percentile in the relative increase) relative increase in obesity prevalence. Using individual-level data from the 1990-2006 cross-sections of the BRFSS, Fletcher, Frisvold and Tefft (2009) found statistically significant but very small associations between soda taxes and adult weight outcomes: a 1 percentage point increase in the state soft drink tax was associated with a 0.003 unit reduction in adult BMI and a 0.01 percentage point decrease in adult obesity prevalence.

Examining adolescents, Powell, Chriqui and Chaloupka (2009) found no statistically significant association between state-level soda taxes and adolescent BMI based on analyses using the MTF cross-sectional data. However, they found a statistically significant but very small effect of state soda taxes applied to vending machines and adolescent BMI among teens at risk for overweight. Specifically, a 1 percentage point increase in the vending machine tax rate was associated with a 0.006 reduction in BMI among adolescents at risk of overweight. In a recent study focused on younger children drawn from the Early Childhood Longitudinal Study-

Kindergarten (ECLS-K) cohort, Sturm et al. (in press) found that higher soda taxes were related to lower BMI change from 3rd to 5th grade but this finding was not robust to alternative model specifications and it stemmed mainly from children already at risk for overweight. Among subpopulations, while they did find that higher soda taxes were significantly associated with lower soda consumption among children in lower-income families, African Americans, heavy television watchers and, heavier children, particularly those reporting soda availability at school, higher soda taxes were only statistically significantly associated with lower BMI gain among children already at risk for overweight and the effect was very small. A one percentage point increase in the soda tax rate was associated with a -0.033 unit change in BMI among heavier children.

3.2. Empirical Evidence for Subsidies

In Table 2, the last column reports on the results from the available evidence examining the relationship between fruit and vegetable prices and weight outcomes to highlight the extent to which fruit and vegetable subsidies may help to reduce obesity. The largest body of evidence to date, including the most consistent findings, is for children. All of the studies drew their fruit and vegetable price data from ACCRA and a number of these studies used longitudinal individual-level data.

The evidence for adults is limited and mixed. Most recently, based on longitudinal data from the 1999-2005 waves of the Panel Study of Income Dynamics (PSID), Powell and Han (in press) found that higher fruit and vegetable prices were related to higher adult female BMI (elasticity of 0.03) but not statistically significantly related to male BMI. In particular, the effects of fruit and vegetable prices were found to be stronger among poor women (elasticity of 0.09) and women with children (elasticity of 0.04) suggesting that targeted subsidies would be most effective. However, Beydoun, Powell and Wang (2008) who drew on cross-sectional data from the 1994-96 CSFII found that fruit and vegetable prices were not statistically significantly associated with obesity and were inversely associated with BMI.

Several of the studies that examined children and adolescents found statistically significant effects of fruit and vegetable prices on weight outcomes, particularly among those who were low-SES or at risk of overweight. Focusing on 8th and 10th grade youths from cross-sectional MTF data, Powell et al. (2007) found the price of fruit and vegetables was positively but not statistically significantly related to BMI or obesity among youths. Also using the MTF data, Auld and Powell (2009) found a very small association between fruit and vegetable prices (elasticity of 0.02) but using quantile regressions models found larger effects, albeit still quite small, among overweight teens: for example, the BMI fruit and vegetable price elasticities were 0.05 and 0.06, respectively, for male and female teens at the 95th BMI quantile.

Using longitudinal data on children from the ECLS-K and a random effects model, Sturm and Datar (2005) found that changes in child weight was positively related to the price of fruit and vegetables: an increase in the price of fruit and vegetables by one standard deviation raised BMI by 0.11 units by third grade (equivalent to a BMI price elasticity of approximately 0.05). Examining a number of subpopulations, Sturm and Datar found that children in poverty and those at risk for overweight were roughly 50% and 39%, respectively, more price sensitive compared to their non-poor and not at risk counterparts. In an extended panel following the ECLS-K children through to fifth grade, Sturm and Datar (2008) estimated that one standard deviation increase in the price of fruit and vegetables increased children's BMI by 0.20 units by fifth grade suggesting a persistent and larger long term effect of fruit and vegetable prices on

children's weight outcomes. Powell and Bao (2009) also estimated a random effects model drawing on data from the 1998, 2000 and 2002 waves of the children of the NLSY79 and found that increasing the price of fruit and vegetables by one standard deviation increased BMI by 0.20 units. In terms of the price elasticity, a 10% reduction in the price of fruits and vegetables was associated with a 0.7% reduction in BMI. The estimated association between fruit and vegetable prices and BMI was stronger among low- versus high-socioeconomic status children with estimated elasticities of 0.14 and 0.09 among low-income children and children with less educated mothers, respectively.

Powell and Chaloupka (in press) estimated an individual-level fixed effects longitudinal model using data from the Child Development Supplement of the PSID and found that higher fruit and vegetable prices were statistically significantly related to a lower BMI percentile ranking among children, with larger effects for children in low-SES families. The fruit and vegetable price elasticity for BMI was estimated to be 0.25 for the full sample and 0.58 among low-income children. The results from this most recent study are consistent with the study findings based on individual-level random effects models that found children's BMI to be sensitive to the price of fruits and vegetables with greater effects for low-SES children.

4. Pricing Policy Design Issues for Obesity Prevention

A number of important issues require consideration in the design and implementation of pricing instruments, particularly in the area of taxation. As the evidence and data presented thus far indicate, the current approach to taxation of unhealthy foods and beverages in the United States is making a marginal impact, at best, on obesogenic behaviors and weight outcomes. Even still, governments at all levels are increasingly exploring the possibility of taxing unhealthy foods and beverages such as sodas (McKinley 2007; Congressional Budget Office 2008; New York State Division of Budget 2009; Patrick and Murray 2009) and the calls for increases in such taxes are mounting (Institute of Medicine 2009a; Brownell et al. 2009b; Brownell and Frieden 2009). Changes to food support programs such as Food Stamps and WIC also are being considered in the context of obesity prevention. However, before pursuing such policy levers in the fight to prevent obesity, a number of factors should be considered including the size of the tax or subsidy intervention, the items to tax or subsidize, and the tax and subsidy design—each is discussed briefly below.

4.1. Size of the Tax or Subsidy

The size or amount of the tax depends heavily on the underlying purpose for the tax. In other words, is taxation being considered as a revenue generation source, as a funding stream for obesity prevention efforts or to try to reduce individual consumption and BMI outcomes? The empirical evidence reviewed in this chapter found very small price elasticities for weight suggesting that large taxes will be needed to have a marked effect on behavior and related weight outcomes. However, as indicated by the data presented earlier in this chapter, most of the taxes imposed to date have been small taxes. While these taxes have a marginal impact, at best, on individual-level behavior changes and BMI outcomes, they hold tremendous potential to raise revenue for cash-strapped governments, to raise revenue to offset medical costs, and to fund obesity prevention programs (Jacobson and Brownell, 2000; Brownell and Frieden, 2009; Brownell et al. 2009b). Indeed, the most recent estimates indicate that the annual economic burden of obesity has risen to 10 percent of all medical expenditures, or approximately $147 billion/year in 2008 (Finkelstein et al. 2009).

In terms of revenue potential, the Rudd Center for Food Policy and Obesity's Revenue Calculator for Soft Drink Taxes for 2010 indicates that a $0.01/ounce additional tax on regular, sugar-sweetened sodas could generate over $955 million in revenue for the state of California and over $210 million in revenue for New York City. In Mississippi, the state with the highest obesity rate in the country, such a tax could generate over $74 million in revenue for the state (Rudd Center for Food Policy and Obesity 2010). In recent years, proposals have emerged at the Federal, state and local levels of government related to the use of these taxes, particularly with regard to regular, sugar-sweetened sodas (Congressional Budget Office 2008; New York State Division of Budget 2009; Patrick and Murray 2009). While none of these recent proposals has passed, such proposals continue to emerge. Most recently, a bill has been introduced in the Mississippi state legislature to impose a 2-cent-per-ounce excise tax on soft drinks, with the revenue generated dedicated to obesity prevention programs. They estimate that such a tax could generate $200 million/year for the state ("Bill seeks …" 2010). Public support for such taxes is likely to be greater when the revenue is specifically designated to prevent obesity, particularly childhood obesity, rather than for general revenue generation purposes (Evans et al. 2005; Cawley 2008).

Finally, the size of subsidies that can be offered for healthful low energy-dense foods or beverage products is largely constrained by available government funds. Revenue generated from taxes on energy-dense items also could be used to offset the cost of providing subsidies to products such as fruits and vegetables. The extent of such subsidies also would help to offset the regressive nature of food taxes.

4.2. What to Tax and or Subsidize?

One of the biggest challenges associated with taxing foods and beverages is "what to tax." Whereas the imposition of food taxes have been called for on the basis of nutrient content (i.e., fat taxes), it is generally recognized that from a legislative vantage it is easier to tax specific categories of food, in particular those with low nutritional value (Jacobson and Brownell 2000; Caraher and Cowburn 2005). Similarly, categories of food such as fruits and vegetables or low-fat milk, for example, are clearly more straight forward candidates for subsidies rather than measuring the extent of nutrient content across multiple product categories.

Currently, the taxes applied to sodas and snack products, for example, are based largely on the category of food or on the definition of "food" as used by the given state or locality. In most cases, when a given item such as regular, sugar-sweetened soda or candy is taxed, it is because such items have been removed from the list of items that are otherwise exempt from the state sales tax and, therefore, become taxable items. However, even within products, such as candy, debate surrounds the ingredients that comprise the end product and whether the end product should be taxed given that some of its ingredients are healthy. For example, "candy" is often a challenging item to consider for taxation purposes because many candy items contain milk or milk-based ingredients, flour and other ingredients that would not be considered candy but, rather, "food." Regular, sugar-sweetened sodas, however, do not contain any items of nutritional value and have been shown to contribute to rising obesity rates and other chronic disease conditions (Wang et al. 2008; Bleich et al. 2009; Wang et al. 2009). Thus, sodas are an easier item to target for taxation purposes from an obesity-prevention standpoint than candy products.

Within product categories, the application of taxes to the broadest base possible is likely to be most successful for obesity prevention objectives because the inclusion of more products

would help to limit substitution across products. For example, the application of a tax to a broader set of sugar-sweetened beverages as opposed to a narrow soda tax would limit substitution between soda and other sugared beverages thereby increasing the likelihood of lowering total overall caloric intake and reducing related weight outcomes.

4.3. Policy Instrument Design

From a design perspective, the level of government and type of tax levied are important considerations. Currently, there is no federal tax (sale or excise) on foods and beverages. Thus, all such taxation, where it exists, occurs at the state and, to some extent, local levels of government. As noted earlier, this patchwork approach has led to tax variations both across and within states, by location of sale (e.g., grocery stores versus vending machines), and by product or item (e.g., sodas, potato chips, candy). For example, the state sales tax rate on regular, sugar-sweetened sodas sold in grocery stores ranges from 0 to 7 percent and in vending machines from 0 to 8 percent, exclusive of additional local sales taxes that apply in many counties and municipalities in the United States. Thus, the tax "burden" (albeit small) will vary depending on the state within which and the location from which one purchases the given item. A federal tax, on the other hand, would apply to all consumers and not just consumers in a given state and/or locality. And, when combined with state/local taxes, federal taxes could have an additive impact on consumption behaviors and revenue generation. One estimate indicates that a 1-cent per ounce national tax on sugar-sweetened beverages would generate $14.9 billion in the first year alone which could be used for revenue generation and obesity-prevention purposes (Brownell et al. 2009b). In fact, during the health care reform debates in Congress, one proposal emerged to impose a 3-cent excise tax per 12 ounces of sugar-sweetened beverages as a way to generate revenue to help offset the costs associated with health care reform. The Congressional Budget Office estimated that such an option would have generated an estimated $24 billion in revenue for the 2009-2013 period (Congressional Budget Office 2008).

In addition, a federal tax would be uniform across states and it would be universally applied across populations including those who make purchases using food stamps. Food purchases under the Food Stamp program are exempt from any state-level tax (7 CFR §272.1). Thus, if the objective of the tax policy is to alter food consumption behavior, then the imposition of or increases in state-level taxes cannot be expected to impact purchasing behaviors among low-income food stamp recipients. In terms of subsidies, a federal policy would help to ensure the most uniform and nationally comprehensive coverage to improve population health. The empirical evidence showed that subsidies targeted to low-SES populations had the potential for the greatest impact on weight outcomes. Thus, the delivery of targeted subsidies could be nationally operationalized through existing USDA food programs such as Food Stamps, WIC, and school meal programs.

A final important design issue, the form of taxation—whether sales, excise, privilege, etc.—must be considered. Several key arguments can be made in favor of an excise versus a sales tax, regardless of whether the tax is at the federal, state, or local level. First, excise taxes have the benefit of being incorporated into the shelf price of the given product (and, hence, are part of the visible price seen by consumers); whereas, a sales tax is only applied at the point of purchase, after the decision to select and purchase the item has been made. With the few exceptions noted earlier in this chapter, most of the current taxes applied to unhealthy foods and beverages are sales taxes that are only applied at the point of purchase. Second, excise taxes would apply regardless of where the items were sold. That is, for example, the tax would apply

whether sold in grocery stores, vending machines, school or any other venue. Third, excise taxes which are applied on a per unit measure are more effective in raising prices when volume discounts are given compared to sales taxes which are applied as a percentage of price.

5. Conclusions

Evidence from empirical models that examine the effects of prices (or taxes) directly on weight outcomes help to assess whether changes in prices may translate to significant changes in BMI or obesity prevalence. The review of such study findings in this paper suggests that that small tax- or subsidy-related price changes would not likely produce substantial changes in BMI or obesity prevalence. However, non-trivial pricing interventions may have measurable effects, particularly among low-SES populations and those most at risk for overweight and such interventions may have larger impacts at the population level when applied widely. Among adults, some of the price evidence showed that higher prices of energy-dense foods (such as fast food, sugar and calorie dense items) were associated with lower weight outcomes. The potential effect of reducing adult weight through subsidies to healthy foods was limited to female adults, and the effect was greater for poor women and those with children. For adolescents, the empirical evidence supported changing relative prices by both taxing less healthy foods (such as fast food) and subsidizing fruits and vegetables and the effects were found to be greater for those youths at risk of overweight. Among children, lower fruit and vegetable prices were consistently estimated to improve weight outcomes. In particular, the evidence suggested that fruit and vegetable subsidies would have the greatest effects among children from low-SES families. Also a number of studies suggested that the price effects on weight were greater in the long run.

Whereas most of the empirical studies drew on price data, several recent studies linked state-level soda taxes to individual-level data. These studies found minimal evidence of a tax effect on weight suggesting that the current soda tax rates are not large enough to generate sufficient changes in consumption that would translate into changes in weight outcomes. Further, given the narrow application of the tax on soda, even though it may reduce soda consumption itself, individuals may substitute to other non-taxed sugar sweetened beverages limiting the potential for the tax to translate into weight changes.

As governments consider moving forward with fiscal pricing policies aimed at obesity prevention, a number of important policy design issues will need to be addressed. As governments assess what products to tax or subsidize they will be faced with issues of practicalities, minimizing adverse substitution behaviors, and undoubtedly industry backlash. The size of the tax will need to be determined based on balancing objectives related to changing behavior and generating revenue that can be used for a range of obesity prevention programs and to help offset the costs of obesity. States that already impose sales taxes on products such as soda and candy will be faced with decisions on whether to expand taxes that are already in place or whether to move to alternative forms of taxation such as excise taxes. Similarly, if subsidies are to be targeted to low-SES populations, a number of current federal food programs may be used as a vehicle for delivery. Finally, with respect to tax design, excise taxes were shown to potentially be a better tax design for obesity prevention given their visibility at the shelf, their application across different point of sale venues, and the fact that they will persist even when volume discounts are offered. As new taxes and or subsidies are implemented researchers should continue to assess the extent to which such policies impact weight and other health outcomes.

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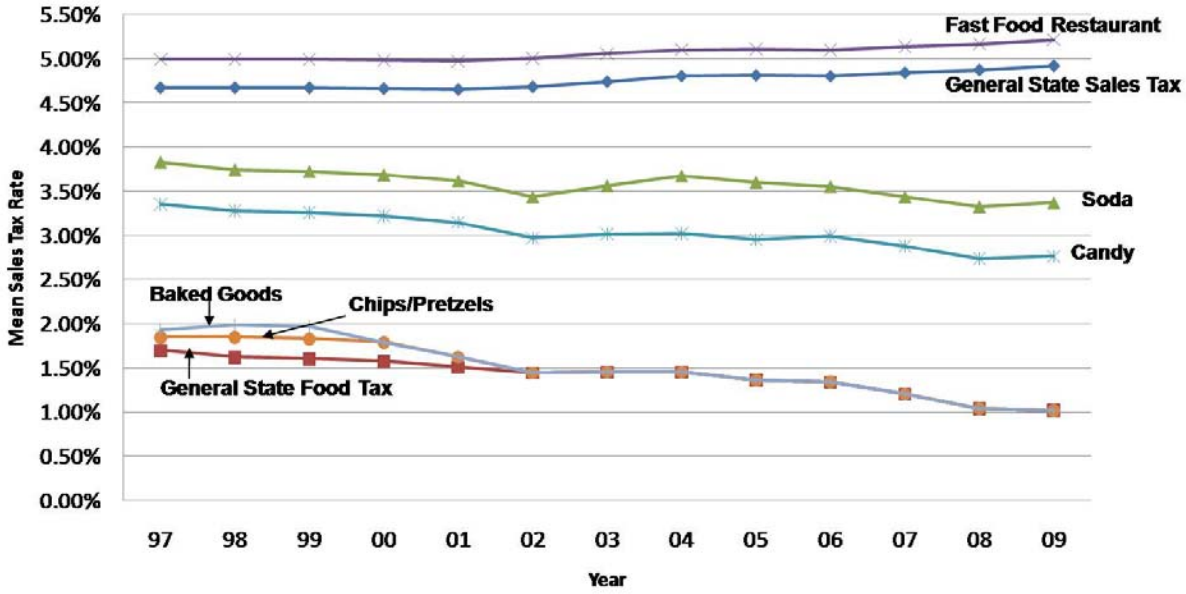
Figure 1: Mean state sales tax rates on food products, regular soda, restaurant sales, and snacks, 1997-2009



Source: Bridging the Gap Program, Health Policy Center, Institute for Health Research and Policy, University of Illinois at Chicago based on data compiled by The MayaTech Corporation. All data reflect tax rates effective as of January 1 of each year and include all 50 states and the District of Columbia.

Table 1: Average State Sales Taxes by Category of Tax/Taxable Item, 2009

Tax Category/Taxable Item	Mean Tax-- All States (N=51; 50 states plus D.C.)	Mean Tax-- States with a Tax	# of States with Tax
General sales tax	4.92%	5.45%	46
General food tax	1.02%	3.70%	14
Fast food restaurant	5.22%	5.66%	47
Soda	3.36%	5.20%	33
Candy	2.76%	4.85%	29
Chips/pretzels	1.02%	3.70%	14
Baked goods	1.02%	3.70%	14

Source: Bridging the Gap Program, Health Policy Center, Institute for Health Research and Policy, University of Illinois at Chicago based on data compiled by The MayaTech Corporation. All data reflect tax rates effective as of January 1, 2009.

Table 2: Evidence on Price Effects on Body Weight Outcomes

Author	Price / Tax Measure (Source)	Data Set	Population	Model	Outcome Measure	Evidence for Tax Effects: Fast Food Prices (FFP), Soft Drink Tax (SDT), Sugar Price (SP), or Price per Calories (PPC) (Direction (Elasticity[1]))	Evidence for Subsidy Effects: Fruit and Vegetable Prices (FVP) (Direction (Elasticity[1]))
Evidence for Adults:							
Chou, Grossman, and Saffer (2004)	Full-service restaurant prices, fast-food restaurant prices, and prices of food at home (ACCRA[2])	BRFSS[3], 1984–1999	Adults18 years and older (*n*=1,111,074)	Cross-sectional	BMI[4]	**FFP: - (0.05)**	N/A
					Obesity	FFP: - (0.65)	N/A
Kim and Kawachi (2006)	State-level taxes on soft drinks and snacks	BRFSS[3], 1991–1998	State-level averages of adults	Cross-sectional	State-level obesity prevalence	N/A	N/A
Miljkovic and Nganje (2008)	Prices of sugar (National Agricultural Statistics Service, USDA[5])	BRFSS[3], 1991, 1997, and 2002	Adults18 years and older (*n*=45,440)	Cross-sectional	Overweight	**SP: - (0.20)**	N/A
					Obesity	**SP: - (0.81)**	N/A
Miljkovic, Nganje, and de Chastenet (2008)	Prices of sugar (National Agricultural Statistics Service, USDA[5])	BRFSS[3], 1991, 1997, and 2002	Adults18 years and older (*n*=55,550)	Cross-sectional	Overweight	**SP: -**	N/A
					Obesity	**SP: -**	N/A
Beydoun, Powell, and Wang (2008)	Prices of fruits and vegetables and fast food (ACCRA[2])	CSFII[6], 1994–1996	Adults aged 20 to 65 (*n*=7331)	Cross-sectional	BMI[4]	FFP: +	**FVP: -**
					Obesity	FFP: +	FVP: +
Fletcher, Frisvold, and Tefft (2009)	Incremental soft drink tax rate and total soft drink tax rate (Web, Lexisnexis Academic Search, and States' Departments of Revenue web sites)	BRFSS[3] 1990-2006	Adults 18 years and older (n=2,709,422)	Pooled Cross-sectional	BMI[4]	**SDT:-**	N/A
					Obesity	**SDT:-**	N/A
					Overweight	**SDT:-**	N/A
Goldman, Lakdawalla, and Zheng (in press)	Price per calorie, price of cigarettes, and price of gasoline (ACCRA[2])	HRS[7] 1992-2004	Adults born between 1931-1941 (n=9,733)	Longitudinal (FE[8])	BMI[4] and log(BMI[4])	**PPC: - (0.06) short run** **PPC: - (0.42) long run**	N/A
Powell and Han (in press)	Price of fruits and vegetables Price of fast food (ACCRA[2])	PSID[9] 1999, 2001, 2003, 2005	Adults 18-65 years old (n=6,045 men and 6,0806 women)	Cross-sectional and Longitudinal (FE[8])	BMI[4]	FFP: -, men, CS[10] FFP: +, men, FE[8] FFP: -, women, CS[10] FFP: +, women, FE[8]	FVP: +, men CS[10] FVP:+, men FE[8] FVP: +, women CS[10] **FVP: +0.02, women FE[8]** **FVP:+0.09, poor women FE[8]** **FVP:+0.03, women with children FE[8]**
Evidence for Children and Adolescents:							
Sturm and Datar 2005	Price indices for meat, fruits and vegetables, dairy, and fast food (ACCRA[2])	ECLS-K[11], 1998–2002	Children K through 3rd grade (*n*=6,918)	Longitudinal	BMI[4]	FFP: not significant and not included in final model	**FVP: - (0.05)**

Powell et al. (2007)	Prices of fruits and vegetables and fast food (ACCRA[2])	MTFS[12], 1997–2003	Adolescents in 8th and 10th grade (*n*=72,854)	Cross-sectional	BMI[4]	**FFP: - (0.04)**	FVP: +
					Overweight	**FFP: - (0.59)**	FVP: +
Auld and Powell (2009)	Prices of fruits and vegetables and fast food (ACCRA[2])	MTFS[12], 1997–2003	Adolescents in 8th and 10th grade (*n*=73,041)	Cross-sectional	BMI[4]	**FFP: - (0.03)** **FFP: - (0.10) male*** **FFP: - (0.11) female*** *at the 90th quantile	**FVP: + (0.03)** **FVP: + (0.05) male*** **FVP: + (0.06) female*** * at the 95th quantile.
Chou, Rashad, and Grossman (2008)	Fast food, full service restaurant, and food at home price (Census of retail trade and ACCRA[2])	NLSY97[13] 1997-1999	Adolescent 12-18 years (n=14,852)	Cross-sectional	BMI[4]	**FFP: -** **FFP: - female** FFP: - male	N/A
					Overweight	FFP: - whole sample, males, and female	N/A
Sturm and Datar (2008)	Price indices for meat, fruits and vegetables, dairy, and fast food (ACCRA[2])	ECLS-K[11], 1998–2004	Children K through 5th grade (*n*=4,557)	Longitudinal	BMI[4]	N/A	**FVP: +, 3rd grade** **FVP: +, 5th grade**
Powell (2009)	Fast food prices (ACCRA[2])	NLSY97[13] 1997-2000	Adolescents 12-17 years old in 1997 (n=11,900)	Cross-sectional, and longitudinal (RE[14], and FE[8])	BMI[4]	**FFP: - (0.10), CS[10]** **FFP: - (0.08), RE[14]** **FFP: - (0.08), FE[8]** **FFP: - (0.13) mother low education, FE[8]** **FFP: - (0.31) middle income, FE[8]**	N/A
Powell and Bao (2009)	Fruit and vegetables and fast food prices (ACCRA[2])	NLSY79[15] 1998-2002	Children 6-18 years old (n=6,594)	Longitudinal (RE[14])	BMI[4]	FFP:- (0.67) **FFP: - (0.26) low income** **FFP: - (0.13) mother low education**	**FVP: + (0.07)** **FVP: + (0.14) low income** **FVP: + (0.09) mother low education**
Powell, Chriqui, and Chaloupka (2009)	Soda taxes (BTG[16])	MTFS[12] 1997-2006	Adolescents 13-19 years old (n=153,673)	Cross-sectional	BMI[4]	SDT: + SDT:-, at risk of overweight. Vending machine SDT:+ **Vending machine SDT: - (0.01), at risk of overweight**	N/A
Powell and Chaloupka (in press)	Fast food and fruit and vegetable prices (ACCRA[2])	CDS-PSID[17] 1997 and 2002/2003	Children 2-18 years old (n=1,629)	Cross-sectional and Longitudinal (FE[8])	BMI[4]	FFP: - (0.16), CS[10] **FFP: - (0.77) low income, CS[10]** FFP: + (0.24), FE[8] FFP: - (0.21) low income, FE[8]	**FVP: + (0.24), CS[10]** **FVP: + (0.27) low income, CS[10]** **FVP: + (0.25), FE[8]** **FVP: + (0.60), low income, FE[8]**
Sturm et al. (in press)	State sales soda tax BTG[16]	ECLS-K[11]	Children (n=7,300)	Cross sectional	BMI[4]	**SDT: -** **SDT: -, at risk overweight** SDT: - low income SDT:+, African American SDT:- watches 9 or more hours of TV	N/A

[1] All directions and elasticity are statistically significant when in bold. Elasticity measures provided when available. Results for selected sub samples noted.
[2] American Chamber of Commerce Researchers Association
[3] Behavior Risk Factor Surveillance System
[4] Body Mass Index
[5] United States Department of Agriculture
[6] Continuing Survey of Food Intakes by Individuals

[7] Health and Retirement Study
[8] Longitudinal individual-level fixed effects
[9] Panel Study of Income Dynamics
[10] Cross sectional model
[11] Early Childhood Longitudinal Study- Kindergarten cohort.
[12] Monitoring the Future Survey.
[13] National Longitudinal Study of Youth 1997
[14] Longitudinal individual-level random effects.
[15] National Longitudinal Study of Youth 1979
[16] Bridging the Gap- Robert Johnson Foundation-supported project, Health Policy Center, University of Illinois at Chicago
[17] Child Development Supplement – Panel Study of Income Dynamics