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John Cawley
David Frisvold
Anna Hill
David Jones

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ABSTRACT

In recent years, numerous cities in the U.S. have enacted taxes on beverages to promote health and raise revenue. This paper examines the impact of Philadelphia's beverage tax, enacted in 2017, on the prices and availability of taxed beverages and untaxed beverages that may be substitutes for consumers. Using original data we collected in late 2016 and again one year later, we estimate a difference-in-differences regression of the change over time in beverage prices and product availability in stores in Philadelphia relative to stores in nearby counties. We find that, on average, distributors and retailers fully pass the tax through to consumers, but there is heterogeneity in the pass-through rate among stores. Pass-through is greater among stores in higher-poverty neighborhoods, stores located farther from untaxed stores outside Philadelphia, stores that are independent as opposed to part of national chains, and for individual servings than for larger sizes. We also find a reduction in the availability of taxed beverages and an increase in the availability of untaxed beverages, particularly bottled water, in Philadelphia stores.

John Cawley
2312 MVR Hall
Department of Policy Analysis and Management
and Department of Economics
Cornell University
Ithaca, NY 14853
and NBER
JHC38@cornell.edu

David Frisvold
Department of Economics
University of Iowa
21 East Market Street
Iowa City, IA 52242
and NBER
david-frisvold@uiowa.edu

Anna Hill
955 Massachusetts Avenue
Suite 801
Cambridge, MA 02139
ahill@mathematica-mpr.com

David Jones
955 Massachusetts Avenue
Suite 801
Cambridge, MA 02139
United States
DJones@mathematica-mpr.com

I. Introduction

In recent years, voters and city councils in cities throughout the U.S. have implemented taxes on sugar-sweetened beverages (SSBs). Berkeley, California, implemented the first tax in 2015. Philadelphia, Pennsylvania; Oakland and Albany, California; and Boulder, Colorado followed in 2017, as did San Francisco, California and Seattle, Washington in 2018. These taxes are part of a broader international trend; such taxes have recently been enacted by countries throughout the world, including Chile, Finland, France, India, Mexico, Peru, the Philippines, Samoa, South Africa, Thailand, and the U.K. (Thow et al., 2018).

Taxes on beverages arose because of concern about diet-related chronic disease and obesity. The prevalence of obesity among U.S. adults has nearly tripled over the last few decades, from 13.4 percent in 1960–62 to 39.6 percent in 2015–16 (Fryar et al., 2016; Hales et al., 2017). Likewise, the prevalence of obesity among U.S. children rose from 13.9 percent in 1999-2000 to 18.5 percent in 2015-2016 (Hales et al., 2017). Between 1980 and 2014, the number of U.S. adults with diabetes rose 176 percent, from 8.1 to 22.4 million (NCD Risk Factor Collaboration, 2016). SSBs contribute to the rise in obesity and diabetes because they are high in calories, have zero nutrients, are not satiating (thus resulting in greater calorie intake), and have a high glycemic load (Malik & Hu, 2011; Hill et al., 2013).

Policymakers have implemented these taxes for a variety of reasons, including raising revenue and discouraging consumption by increasing prices. However, evidence on the impacts of these recent taxes is limited. The purpose of this paper is to estimate the impact of the beverage tax in Philadelphia on retail prices and product availability, thereby contributing to the growing evidence on the impacts of these taxes. Philadelphia implemented an excise tax of 1.5 cents per ounce on January 1, 2017. This tax is of particular interest because Philadelphia is the only city to levy a tax on both diet and regular caloric beverages (unsweetened beverages remain exempt).[1]

We study two outcomes in this paper: beverage prices and product availability. The first outcome, beverage prices, determines the pass-through rate and the incidence of the tax. Like all

[1] An earlier proposal called for a tax of 3 cents per ounce on caloric, sweetened beverages. The Philadelphia City Council reduced the tax to 1.5 cents per ounce but expanded it to include sweetened non-caloric beverages, such as diet soda. The tax does not apply to unsweetened drinks or to sweetened beverages in which more than 50 percent of the beverage is milk, fruit, or vegetables. For example, the tax applies to regular soda, diet soda, juice drinks, sports drinks, energy drinks, pre-sweetened coffee and tea, flavored water, and mixers for alcoholic drinks, but it does not apply to bottled water, unsweetened iced tea, and chocolate milk.

of the other city-level beverage taxes, Philadelphia's is levied on distributors. However, it is well-established in the literature that the incidence of a tax is determined not by the party being taxed, but on factors such as the local market structure and the relative elasticities of supply and demand (Kotlikoff & Summers, 1987; Fullerton & Metcalf, 2002; Weyl & Fabinger, 2013). The elasticities of supply and demand may vary by type of store (e.g., convenience store versus large supermarket), by volume (e.g., 20-ounce bottles versus 2-liter bottles), and by type of product (e.g., regular soda versus diet soda) (Powell, Chriqui, Khan, Wada, & Chaloupka, 2013; Cawley & Frisvold, 2017). Thus, we examine whether the pass-through of the tax varies based on the characteristics of the product and retailer. The incidence of these taxes is important for understanding the extent to which they result in higher retail prices, and it sheds light on whether the taxes may be regressive by indicating the proportion of the tax paid by consumers.

The second outcome we examine, product availability, has not been studied in any earlier research on city beverage taxes in the U.S. Store owners and managers may respond to a beverage tax—and any resulting decrease in demand—by ceasing to stock certain taxed items or by stocking more untaxed items, such as bottled water. This response could represent another way in which the tax affects consumption—not simply by raising prices, but also by increasing the difficulty of acquiring taxed beverages. Also, at the same time that the Philadelphia tax was implemented, the city implemented a Healthy Beverage Tax Credit, which provides a tax credit of up to $2,000 per year for small retailers, but not for grocery stores, to stock unsweetened beverages.[2] The tax credit may affect the availability of untaxed beverages (which are subsidized) and taxed beverages (which are not subsidized and thus may be crowded out) separately from any effect of the tax. However, any such effect would exist only in smaller retailers that are eligible for the credit, not in grocery stores or supermarkets that are ineligible, which allows us to isolate its effect.

We study these outcomes using original data collected in person at stores. Specifically, we collected data on the price and availability of a wide range of beverages in retail stores in

[2] The Healthy Beverage Tax Credit is available only to certain types of retailers: convenience stores (NAICS code 44512), other specialty food stores (NAICS 44529), miscellaneous food retailers (NAICS 44599), gas stations with convenience stores (NAICS 44711), and limited-service restaurants (NAICS 722513). Such retailers are eligible for a tax credit of up to $2,000 for the additional costs, relative to the previous year, of stocking unsweetened beverages (in effect, small retailers receive $2,000 worth of unsweetened beverages if they are willing to set aside the shelf space). Retailers receive the credit in 2018 after filing their 2017 taxes. Grocery stores are not eligible to receive this credit.

Philadelphia and nearby counties in November and December 2016 (before the tax took effect in January 2017). We returned to the same retailers after the tax began, during the same months (November and December) the following year (2017), and used the same data collection procedures. We use these data to estimate difference-in-differences (DiD) regressions, comparing the changes over time in prices and availability in Philadelphia stores relative to stores in nearby, untaxed communities.

A few studies have examined the pass-through of city-level beverage taxes in the U.S. For example, Cawley and Frisvold (2017) and Falbe, Rojas, Grummon, and Madsen (2015) compared the changes in prices before and after the beverage tax in Berkeley to the change in prices in nearby control cities, such as San Francisco; they both found that retailers passed 40 to 50 percent of the tax through to consumers. Cawley, Crain, Frisvold, and Jones (2018b) compared the changes in prices for retailers and restaurants before and after the beverage tax in Boulder to those outside of the city—in Boulder County and nearby in Fort Collins—and estimated a pass-through rate of 81 percent for retail stores and 69 percent for restaurants.

These results for Berkeley and Boulder do not necessarily generalize to Philadelphia; pass-through may vary across cities because the size and scope of the tax differ, the residents vary in their elasticities of demand, the local markets for beverage distributors or groceries are differentially competitive, or the cities differ in the ease with which consumers can evade the tax by cross-border shopping. Philadelphia, which spans 134 square miles and has a population of 1.6 million, is much larger than Berkeley or Boulder (United States Census Bureau, 2017). Philadelphia is also a diverse city; 25.3 percent of residents live in poverty, 14.8 percent of residents are Hispanic, 43.9 percent of residents are black, and 44.8 percent of residents are white.[3] There are more than 2,000 beverage distributors registered with the city and over 1,300 beverage retailers.[4] In addition, Philadelphia retailors are likely to face substantial competition from nearby untaxed competitors. The border of the city to the east is the Delaware River, which

[3] Berkeley spans 18 square miles with a population of 112,580. Fifty-five percent of residents are white, 9.7 percent of residents are black, and 10.8 percent of residents are Hispanic. Boulder spans 26 square miles with a population of 97,385. Eighty-eight percent of residents are white, 0.9 percent of residents are black, and 8.7 percent of residents are Hispanic.

[4] Beverage distributors registered with the city, as of April 3, 2018, are listed at http://www.phillybevtax.com/Distributors/Registered-Dealers. The number of beverage retailers is based on ReferenceUSA data as of September 2016.

separates the city from New Jersey, but it is regularly crossed by commuters. The borders on the other sides of the city are less pronounced, with retailers near the city border.

There has been one previous study of the Philadelphia beverage tax. Cawley, Frisvold, and Willage (2018a) estimated the pass-through of the tax, exploiting as a natural experiment the Philadelphia International Airport, which straddles the city border and has locations of the same chains on both the taxed and untaxed sides of the airport. The authors' DiD estimates indicate that 55 percent of the tax was passed through to consumers less than two months after implementation. When the authors considered only the change in prices in taxed stores (out of a concern that control stores raised prices in response to the tax), the pass-through was 93 percent.[5]

We collected new store-level data throughout Philadelphia and the nearby comparison communities to estimate the pass-through of the Philadelphia beverage tax, which is an important topic in public finance. This paper makes the following contributions to the literature: (1) we examine the impact of beverage taxes, which are relatively novel given that they were nearly unknown 10 years ago but have spread widely internationally and have been passed by several major U.S. cities; (2) we examine how stores alter the availability of beverages in response to the tax, which has not been previously studied; (3) we are the first to present estimates of pass-through for the entire city of Philadelphia, which is noteworthy because it was the second city (after Berkeley) to implement such a tax, remains the only city to tax diet beverages, and is far larger and more populous than the two cities previously studied; (4) we examine how pass-through varies by type of store (e.g., large supermarkets versus convenience stores), size of product (e.g., 20-ounce versus 2-liter), type of product (e.g., regular soda versus diet soda), distance to the nearest untaxed store outside of the city, and characteristics of the local population (e.g., percentage of families living in poverty); and (5) we examine the impact on price and availability nearly one year after the introduction of the tax, which is a longer period than most previous studies in the literature, giving retailers and consumers time to adjust and enabling us to observe longer-run impacts of the tax.

In brief, we find that the Philadelphia tax was fully passed through to consumers in the form of higher retail prices. We also find evidence of interesting heterogeneity—i.e., pass-

[5] These results for city-level taxes in the U.S. differ from estimates based on other countries, which tend to show pass-through rates above 100 percent (e.g., Grogger, 2015; Berardi, Sevestre, Tepaut, & Vigneron, 2012; Bergman & Hansen, 2010). However, these country-level estimates are based on changes in prices over time in the taxed country and lack comparison groups.

through was higher for stores that were farther from rivals selling untaxed beverages, as well as higher in high-poverty neighborhoods, in independent stores versus national chains, and for individual servings versus larger sizes. We also find a reduction in the availability of taxed beverages and an increase in the availability of untaxed beverages, particularly bottled water, in Philadelphia stores.

II. Methods

We estimate the effects of the tax using a DiD design, which compares the change in outcomes in stores in Philadelphia to those in stores in comparison (or control) communities. The DiD equations are of the general form:

$$Y_{ist} = \alpha + \beta_1 Post_t + \beta_2 Phila_s + \beta_3 Phila_s * Post_t + \beta_4 S_s + \delta_i + \varepsilon_{ist},$$

where Y_{ist} is either the price per ounce or availability of the beverage *i* in store *s* in time period *t*. *Phila* is a binary variable equal to 1 if the store is in Philadelphia and equal to 0 if the store is in a comparison area. *Post* indicates that an observation occurred after the Philadelphia tax took effect. S_s is a vector of indicators for store type: stand-alone convenience stores, gas stations with convenience stores, small grocery stores, pharmacies, and warehouse stores; large grocery stores are the omitted store type.[6] δ_i is a vector of product fixed effects. β_3 is the coefficient of interest and represents the change in the outcome (price per ounce or availability of beverages) before the tax to after the tax, in Philadelphia relative to the comparison communities. The regression is estimated using ordinary least squares when the outcome is price; it is estimated by logistic regression when the outcome is an indicator variable for product availability. In all cases, we cluster standard errors at the store level to account for correlations between observations within stores.[7]

[6] We define store types using NAICS codes: convenience stores (445120); gas stations with convenience stores (447110); warehouse clubs and supercenters (452910); pharmacies and drug stores (446110); large grocery stores (445110), which are supermarkets and other grocery stores with annual sales equal to or greater than $750,000; small grocery stores (445110), which are supermarkets and other grocery stores with annual sales less than $750,000. Note that we restricted pharmacies to three chains (CVS, Rite Aid, and Walgreens) due to the difficulty of identifying pharmacies that sold beverages.

[7] With only two geographic regions, standard errors that are clustered at the geographic level would be degenerate (Donald & Lang, 2007). As a result, we cluster standard errors at the store level, following Cawley and Frisvold (2017).

We begin by estimating the impact of the Philadelphia tax on the prices of all taxed beverages. We also separately estimate the impact of the tax on untaxed beverages, which consumers may treat as substitutes for the taxed beverages, and the tax may lead to a shift in demand for the untaxed beverages, raising their price. As mentioned earlier, the elasticities of supply and demand may vary by product, so we also estimate regressions separately for each category of taxed product: regular soda, diet soda, energy drinks (e.g., Red Bull), sports drinks (e.g., Gatorade), sweetened teas, and sweetened juice drinks. We also examine the impact of untaxed beverages by category: juice and water.

In addition, we estimate the differential effects of the tax on prices by store type, chain versus independent stores, product size, characteristics of the local population, and travel time to the closest untaxed competitor. We do this by including interaction terms of the DiD term ($Phila_s * Post_t$) and the given subgroup variable. For example, we estimate the differential impact of the tax for chain stores relative to independent retailers by interacting an indicator variable for chain stores with the DiD term in the model. We estimate the differential impact of the tax by travel time to the closest untaxed competitor by interacting the continuous travel time variable with the DiD term.[8]

We examine the differential impacts by type of store because they may have different elasticities of supply and face different elasticities of demand. For example, people may have relatively inelastic demand when shopping at a convenience store because they are not willing to walk several blocks to an alternative store for just a few items. Large supermarkets may face much more elastic demand because their customers are more likely to drive and can more easily visit a competing store that offers lower prices.

We also test whether pass-through differs for chain retailers versus independent retailers. Managers of chain stores may have less discretion to set prices than owners of small, independent stores if the chain stores require uniform pricing across stores (DellaVigna & Gentzkow, 2017).

We estimate the differential impact by product size, given that the elasticities of supply and demand may vary across them. Consumers may not be price elastic for a single serving

[8] In this case, we define travel time to the closest untaxed competitor (a continuous variable) as zero for the comparison stores in untaxed areas. Thus, we include the interaction between the DiD term and travel distance—but not the interactions between travel distance and Philadelphia and travel distance and the post period because they are identical to the travel time variable and the triple interaction, respectively.

(e.g., a 20-ounce bottle) but may be more price-sensitive regarding 2-liter bottles or multi-packs (e.g., 12-packs of 12-ounce cans), which may be purchased as part of a larger weekly trip for which they drive.

We also investigate the extent to which pass-through of the tax varies based on the distance of the taxed store from the closest rival store selling untaxed beverages. This distance estimates the ease to which that store's clientele can cross the border to evade the tax. Stores closer to rivals selling untaxed beverages may pass through less of the tax than stores farther from such competitors. Cawley and Frisvold (2017) found evidence of such a pattern in Berkeley, while Cawley et al. (2018b) did not find that the distance to the nearest untaxed competitor influenced the pass-through rate in Boulder. We measure the ease of cross-border shopping as the travel time (for a vehicle in minutes) from the store to the nearest untaxed competitor.

We further estimate whether the pass-through rate varies by the characteristics of the neighborhood surrounding the store. Given that individuals travel different distances, on average, to convenience stores compared with grocery stores, we define the area of the neighborhood differently for different store types, as further described below. We focus on three characteristics of the local population: the percentage of households in poverty, the percentage of the population that is African-American, and the percentage of the population that is Hispanic. Whether the pass-through rate varies with the local poverty rate is of interest for two reasons. First, Lin et al. (2011) find that the elasticity of demand for regular soda is greater for individuals with greater incomes. Second, it sheds light on how the burden of the tax differs across neighborhoods and whether the tax is regressive.

We also examine heterogeneity in the impacts of the tax on beverage availability. In particular, it is important to estimate the impact by store type given that the Healthy Beverage Tax Credit applies to convenience stores and gas stations with convenience stores, but not to grocery and other stores.[9] Thus, if any impact on product availability were due to the tax credit and not the tax, the effects would be concentrated among eligible retailers. Impacts on product availability at grocery stores, pharmacies, or warehouse stores would be due to the tax and not the tax credit.

[9] We also note that the tax credit could affect the price charged for untaxed and taxed beverages, given that the credit is a subsidy for stocking unsweetened beverages.

III. Samples of Treatment and Comparison Stores

An important identifying assumption of the DiD model is that, in the absence of the tax, the trend in outcomes in Philadelphia would be equal to the trend in the comparison communities. It is therefore desirable that the stores in Philadelphia and the comparison area experience any unobserved shocks to the outcomes equally. For this reason, we selected comparison stores that were outside the city of Philadelphia (and thus were untaxed) but were still within the Philadelphia Metropolitan Statistical Area (MSA) and within Pennsylvania. Specifically, we selected stores in Delaware, Montgomery, and Bucks counties (the city of Philadelphia is coterminous with the county of Philadelphia). From the Nielsen Retail Scanner Data (referred to as RMS data), we find supporting evidence that the trends in prices are parallel for retailers in Philadelphia and the area outside of Philadelphia but in the Philadelphia MSA.[10] As shown in Appendix Figure 1, the trends in the average weekly price per ounce of regular soda, diet soda, and juice drinks are generally parallel in the year prior to the tax. The price is consistently about 0.2 cents per ounce higher in retail stores in the Philadelphia MSA than in retail stores in Philadelphia throughout 2016.[11] There are differences, however, in the price levels in the RMS data and in the demographic characteristics of residents in Philadelphia and the Philadelphia MSA. We sought to minimize these differences by selecting a set of comparison stores, which we matched to stores within the city based on store type and the population characteristics of the surrounding neighborhood.

Within Philadelphia, we constructed a sample of retail stores that are representative of sales at the types of stores selling SSBs. The retailers listed in the ReferenceUSA database served as our sample frame. We stratified stores by type (convenience stores, gas stations, pharmacies, small groceries, large groceries, and warehouse stores) and allocated the sample of

[10] Using the RMS data, we examined the average weekly price per ounce of regular soda, diet soda, and juice drinks for all retailers in Philadelphia and the Philadelphia MSA. Each retailer in the data set reports the weekly price and sales volume for every UPC code with any sales volume during the week. Based on the UPC code, Nielsen categorizes beverage types. Sports drinks, energy drinks, and sweetened teas are not defined separately in the data. The RMS data include the three-digit zip code and the FIPS county code of each store, so we were able to determine which retailers are located in the city of Philadelphia and in the Philadelphia MSA outside of Philadelphia. According to the RMS data, there were about 24,000 regular sodas; 18,000 diet sodas; and 19,000 juice drinks sold in retail stores in Philadelphia each week during 2016 and about 15,000 regular sodas; 9,000 diet sodas; and 11,000 juice drinks sold in retail stores in the Philadelphia MSA each week.

[11] The conclusions drawn from the Nielsen data are those of the researchers and do not reflect the views of Nielsen. Nielsen is not responsible for, had no role in, and was not involved in analyzing and preparing the results reported herein.

stores proportionally, with a small oversample of small grocery stores and convenience stores to facilitate estimates of pass-through by store type. We then selected stores within each store type stratum that had a probability proportional to our measure of sales from the ReferenceUSA database. The distributions of sociodemographic characteristics, such as the percentage African-American, percentage Hispanic, and percentage in poverty, for the surrounding neighborhoods of the stores in our sample are similar to the distributions for the city as a whole.

We then matched stores in the comparison communities to the sample of stores in Philadelphia based on store type and the percentage African-American, percentage Hispanic, and percentage in poverty in the areas where the store is located.[12] For each store in the Philadelphia sample, we selected a comparison store of the same store type with the closest composite measure of the three population characteristics. We then compared the distributions of the three population characteristics for the Philadelphia stores and matched comparison stores to ensure that we had a high degree of overlap in aggregate for each population characteristic. This approach resulted in a sample of stores in Philadelphia and in the MSA outside of the city that are similar types of stores and serve similar populations.

We collected data from stores on the posted shelf prices of 38 taxed and 8 untaxed products across a range of beverage types, manufacturers, and container sizes. To ensure comparability across stores and over time, we collected the prices of specific sizes of specific branded items, such as Coke, Diet Coke, Arizona Iced Tea, Minute Maid Lemonade, Tropicana 100% Orange Juice, and Dasani bottled water; see Appendix Table 1 for a complete list. We collected the information at two points in time one year apart: November to December 2016 and November to December 2017.[13] We recorded prices in the same month in both years because beverage prices may be seasonal.[14]

[12] We defined a buffer around each store that captures the population of potential shoppers. The buffers varied from radii of 0.5 miles for small convenience stores with relatively small sales volumes to 5 miles for larger warehouse stores that attract shoppers from farther away. For each store, we aggregated the population characteristics of the census-block groups that were contained within or intersected the buffer. For block groups that intersected buffers, we proportionally allocated the population to the store buffers based on the area of the block group that intersected with the buffer.

[13] In all of the regressions reported in this paper, we used the listed price for a single item. However, we also collected information on whether the store was offering any multi-buy promotions (e.g., two for the price of one) or offered a discount for loyalty club members only, and as a robustness check, we estimated our regressions using those lower prices as relevant. The general patterns of results are robust.

[14] Besides recording a large number of posted (or shelf) prices in each store, we also purchased a taxed beverage from each store and reviewed the receipt to determine whether the tax was being applied at the register and thus would not be reflected in the posted or shelf prices. None of the stores we visited applied the tax at the register. This

For 2016, the sample includes 66 stores in Philadelphia with prices for 1,253 taxed beverages and 134 untaxed beverages. For 2017, the sample includes 64 stores with prices for 1,052 taxed beverages and 158 untaxed beverages. In the comparison areas (outside the city but within the Philadelphia MSA), the sample includes 78 stores with prices for 1,562 taxed beverages and 203 untaxed beverages in 2016 and 74 stores, and prices for 1,366 taxed beverages and 187 untaxed beverages in 2017. The small loss of stores at follow-up was due to store closures.

Table 1 shows the average price per ounce of taxed and untaxed beverages in Philadelphia and in the comparison communities in 2016 and 2017. In Philadelphia, the average price per ounce of all taxed beverages in 2016 was 7.474 cents, compared with 7.865 cents outside the city. The differences between stores in the treatment and comparison areas prior to the implementation of the tax are smaller within beverage types. Matching stores outside of Philadelphia to stores in Philadelphia reduces such differences in price across geographic groups within beverage types before the tax compared with the differences shown in the Nielsen Retail Scanner Dataset in 2016, but it does not eliminate the differences.[15] To adjust the sample to be more comparable—and to account for differences in the availability of beverages and differences in the prices of available beverages—we focus on a balanced sample (products available in stores in both 2016 and 2017) for most of the analysis, and we include product-specific fixed effects in the regressions. Of the sample stores in Philadelphia and the Philadelphia MSA in both 2016 and 2017, 24.6 percent are large grocery stores, 7.2 percent are warehouse stores, 27.5 percent are small grocery stores, 15.9 percent are convenience stores, 8.7 percent are convenience stores with gas stations, and 15.9 percent are pharmacies. There are 4,022 store/products combinations represented in the balanced sample in Philadelphia and comparison stores and in the baseline and follow-up data collection.

As further shown in Table 1, the change in prices over time is much larger in Philadelphia than in the comparison communities. The change between 2016 and 2017 in the

is relevant because taxes tend to have a greater impact on consumer behavior when they are more salient (e.g., Chetty, Looney, and Kroft, 2009).

[15] For example, the prices of retailers in the comparison communities in 2016 are 0.175 cents per ounce higher for regular soda, 0.061 cents per ounce higher for diet soda, and 0.06 cents per ounce higher for juice drinks than the prices of retailers in Philadelphia. In contrast, among the retailers in the Nielsen Retail Scanner Data, the prices of retailers in the Philadelphia MSA are about 0.3 cents per ounce higher for regular soda, 0.1 cents per ounce lower for diet soda, and 0.4 cents per ounce higher for juice drinks than the prices of retailers in Philadelphia.

price of all taxed beverages is 1.859 cents per ounce in Philadelphia versus only 0.392 cents per ounce in the comparison communities. In contrast, there is little difference between Philadelphia and the comparison communities in the change in prices of untaxed beverages: 0.343 in Philadelphia and 0.424 in the comparison communities. This suggests that the difference in unconditional differences seen in the prices of taxed beverages is not due to some other shock to beverage prices in Philadelphia. We present the regression-adjusted DiD estimates for the balanced sample in the section below.

IV. Results

Table 2 lists the DiD estimates for the price per ounce of all taxed beverages, untaxed beverages, and each beverage type in the full sample and the balanced sample. For the full sample (column 1), the prices of all taxed beverages rose 1.558 cents per ounce more in Philadelphia stores than in the comparison stores after the tax—a pass-through rate of 104 percent.[16] Based on the standard error of 0.172 and the confidence interval of (1.22, 1.90), this estimate is statistically different from zero at the 5 percent level.[17] The estimate is similar to the unconditional DiD estimate of 1.467 cents per ounce from Table 1; i.e., the change in prices in Philadelphia of 1.859 net of the changes outside of Philadelphia of 0.392 cents per ounce. The estimates based on the balanced sample of stores and products (column 2) are very similar (1.582 cents per ounce). This sample is restricted to products available in stores in both 2016 and 2017, which eliminates the influence of changes in product availability on the estimates of pass-through. For this reason, for the remainder of the paper, we display results based on the balanced sample of stores and products.

The subsequent rows of Table 2 indicate that pass-through is also complete for specific categories of taxed beverages, such as all SSBs (which includes regular soda, sports drinks, energy drinks, juice drinks, and sweetened tea), regular soda, and diet soda.[18] The pass-through

[16] These results are robust to weighting store observations based on their sales volume for 2016 reported in ReferenceUSA and adjusting for a small oversample of smaller stores, a small oversample of stores with large local populations of Hispanic residents to support a follow-up analysis of purchases and consumption, and limited non-response of stores in 2017. Because not all products are sold in all stores and store types, when examining heterogeneity in pass-through rates, the weighted estimates overemphasize products sold primarily in grocery stores. Thus, we report unweighted estimates throughout this paper.

[17] We define statistical significance as the 5 percent level throughout the rest of this paper unless otherwise noted.

[18] For brevity, we report estimates for only the two most commonly consumed types of beverages that are taxed (regular soda and diet soda).

rate varies for other types of beverages, with the largest estimates for energy drinks (1.998 cents per ounce) and juice drinks (1.928 cents per ounce) and the smallest estimates for sports drinks (1.267 cents per ounce) and sweetened teas (1.038 cents per ounce). However, given the standard errors, the pass-through rates are not statistically different across beverage types, and we cannot rule out full (100 percent) pass-through for each type of beverage. The estimates are statistically different from zero at the 5 percent level for all beverage types, except for energy drinks.

For untaxed beverages, the estimated change in prices in Philadelphia relative to the comparison stores is 0.759 cents per ounce, which is roughly half of the amount of the tax. This estimate is statistically different from zero, although well below the estimated pass-through for taxed beverages. The estimate for bottled water is lower, 0.434 cents per ounce, and it is statistically different from zero. The estimate for all untaxed beverages is driven by a relative price increase in juice (in particular, Tropicana Orange Juice), which increased by 1.089 cents per ounce in Philadelphia relative to the comparison communities, or roughly 73 percent of the amount of the tax.[19]

We next present evidence on how the availability of specific types of beverages changed for the entire sample of stores, for stores eligible for the tax credit (stand-alone convenience stores and gas stations with convenience stores), and for stores not eligible for the tax credit (large grocery stores, warehouse stores, small grocery stores, and pharmacies). Table 3 shows that the availability of taxed and untaxed beverages changed after the implementation of the tax.[20] Specifically, the probability that stores carried a given taxed beverage fell by 4.3 percentage points (8.8 percent of the mean of 48.8), which is statistically significant at the 10 percent level. For both stores eligible for the Healthy Beverage Tax Credit (convenience stores and gas stations with convenience stores) and all other stores types not eligible for the credit combined, the point estimates were negative and similar in magnitude, but not statistically significant. Among taxed beverages, the availability of regular soda declined by 7.4 percentage

[19] A potential reason for this price increase is uncertainty about whether this product is taxed. The original legislation that the city council approved only exempted juice from fresh fruit or fresh vegetables, so that Tropicana Orange Juice would have been taxed. However, the final regulations changed this facet so that Tropicana Orange Juice was not taxed.

[20] Unlike the analysis of the impact on prices, in which the regressions include a record for store-beverage combinations only when the beverages are sold at the stores, these regressions include a record for every possible store-beverage combination regardless of whether the beverage is sold at the store, and the dependent variable is an indicator of whether the given beverage is sold at the store.

points and diet soda by 8.3 percentage points, on average, among stores not eligible for the tax credit, although the decrease for regular soda was only statistically significant at the 10 percent level. The reductions in availability were less precisely estimated for stores eligible for the tax credit.

The probability that Philadelphia stores, relative to the comparison stores, carried untaxed beverages increased by 5.2 percentage points for all stores (17.2 percent of the mean of 30.3); the increase of 2.2 percentage points for eligible stores was not statistically significant. For the stores not eligible for the credit, the probability of carrying a given untaxed beverage increased by 6.2 percentage points (18.7 percent of the mean of 33.2). Because these stores were not eligible for the tax credit, this change is presumably solely due to the tax. In particular, Philadelphia stores were more likely to carry bottled water, with an increase of 10.9 percentage points overall and 10.3 percentage points for ineligible stores. The increase of 12.1 percentage points for eligible stores was not precisely estimated.

In summary, it appears that stores shifted away from offering regular soda and diet soda, and towards offering bottled water, because of the beverage tax. These changes are likely not due to the tax credit because these changes occur (and are sometimes larger) in the larger stores that were ineligible for the tax credit. Although policymakers may introduce beverage taxes to increase the prices of the taxed items, these changes in availability represent a largely unanticipated way in which the tax may affect consumer behavior.

A. Heterogeneous Impacts

We next investigate how the pass-through rate varies by store type. Table 4 lists the results for all taxed beverages and for selected types of taxed beverages (regular and diet soda). The first column shows the pass-through rates for large grocery stores, and each additional column shows the differential impacts relative to large grocery stores for the store type listed in the column heading, based on adding interaction terms with all listed store type variables.

As shown in the rows for all taxed beverages, the price increase for large grocery stores is 1.179 cents per ounce, or roughly 80 percent of the tax. The pass-through for gas stations is 1.593 cents per ounce higher than for large grocery stores. The pass-through for small grocery stores is 0.769 cents per ounce higher than for large grocery stores, but this difference is only statistically significant at the 10 percent level. The point estimates are negative for pharmacies

and positive for convenience stores and warehouses, but these estimates are not statistically significant.

Subsequent rows show the pass-through by store type for specific beverage categories. For regular and diet soda, the pass-through is complete for large grocery stores. The pass-through rate is an additional 0.875 cents per ounce higher for regular soda in gas stations and is an additional 0.612 cents per ounce higher for diet soda in warehouse stores. There are no statistically significant differences in the pass-through of other store types relative to large grocery stores.

Table 5 shows how pass-through differs in chain stores, which are identified as branch locations in the ReferenceUSA data, compared with independent retailers. Among independent retailers, pass-through for all taxed beverages is higher than the amount of the tax: 2.107 cents per ounce, or roughly 1.4 times the amount of the tax. Pass-through for chain stores is 1.292 cents per ounce, or 69 percent of the tax—0.815 cents per ounce less than for the independent stores. The pattern is similar for regular soda and diet soda, with the tax overshifted at independent retailers and a lower pass-through rate at chain stores, although the difference between independent and chain retailers is not statistically significant for diet soda. For regular soda, pass-through was 0.634 cents per ounce less at chain stores than at independent retailers, for an overall pass-through of 90 percent in chain stores. These results support the hypothesis that chain stores adjusted prices less than independent retailers in response to the tax.

Table 6 lists estimates of pass-through by product size, grouped as small single servings (up to 23 ounces), large containers (59 ounces and greater), and all multi-packs (e.g., 12-packs of 12-ounce cans or 24-packs of 16.9-ounce bottles).[21] For small single servings, pass-through of the tax was 1.731 cents per ounce (or 115 percent) for all taxed beverages. Pass-through for small beverage sizes was also complete for regular soda (1.817 cents per ounce) and diet soda (1.647 cents per ounce). Relative to small single servings, the pass-through on large containers is lower, although the difference is only statistically significant for regular soda (–0.43 cents per ounce). Likewise, the point estimates suggest that pass-through is lower on multi-packs than on small single servings, but the difference is not statistically significant. In general, across different sizes and categories of beverages, the consistent direction of the point estimates

[21] There are no individual containers with 24 to 58 ounces in our sample.

suggests that pass-through increases with quantity, but the differences are generally not statistically significant.

We test the hypothesis that stores that are farther from untaxed competitors outside of Philadelphia may be able to pass on more of the tax than stores closer to the border in Table 7, focusing on the travel time (for a vehicle in minutes) from the store to the nearest untaxed competitor.[22] Table 7 presents estimates for all taxed beverages, regular soda, and diet soda and for all stores combined, large stores (large grocery stores and warehouse stores), and small stores (stand-alone convenience stores, gas stations with convenience stores, small grocery stores, and pharmacies). For all stores and for all taxed beverages, stores that are farther from the nearest untaxed competitors passed through more of the tax, on average; a one-minute increase in travel time increases pass-through by 0.073 cents per ounce. To put this in context, a store that is an additional 5 minutes in travel time (roughly 40 percent of the mean of 12.046 minutes) from an untaxed competitor increased its prices after the tax by an additional 0.365 cents per ounce (23 percent of the 1.587 cents per ounce mean). The estimates are similar for different store types. For regular soda, the influence of travel time to the nearest untaxed retailer is smaller (roughly 0.5 cents per ounce increase in price for each minute). For diet soda, the influence of distance is smaller and is not statistically different from zero.

Table 8 shows whether the pass-through rate varies by the characteristics of the local population. Specifically, we allow pass-through to vary based on the percentage of households in poverty, the percentage of the population that is African-American, and the percentage of the population that is Hispanic. For all taxed beverages, we see no statistically significant differences in pass-through by these neighborhood characteristics. However, for both regular soda and diet soda, we find that pass-through is higher for neighborhoods with higher rates of poverty. Specifically, a 10 percentage point increase in the poverty rate is associated with a pass-through of the tax that is 0.226 cents per ounce higher for regular soda and 0.210 cents per ounce higher for diet soda. These results imply that the pass-through rate is higher by 0.364 cents per ounce for regular soda (24 percent of the tax) and 0.338 cents per ounce for diet soda

[22] We also estimate regressions in which distance is defined as vehicle miles to the nearest untaxed competitor (Appendix Table 2) and as the distance in miles to the Philadelphia border (Appendix Table 3). The findings are largely consistent with those for travel time (Table 7). Pass-through increases as the travel distance to untaxed competitors and distance to the border increases. For example, a one-mile increase in the travel distance to the nearest untaxed competitor increases pass-through by 0.217 cents per ounce. The pass-through rate at the mean distance (3.229 miles) is 1.585.

(23 percent of the tax) in neighborhoods at the 75th percentile of the poverty distribution (34.2 percent in poverty) compared with the 25th percentile (18.1 percent in poverty). There are no statistically significant differences in pass-through by the percentage of residents who are African-American or Hispanic.

In Appendix Tables 4 through 7, we examine the impact on product availability by store type, chain status, container size, travel time to the nearest untaxed competitor, and neighborhood characteristics. In general, these tables show that, unlike the impact on prices, the impacts on product availability do not vary by these characteristics.

V. Discussion and Conclusion

Several U.S. cities and numerous countries have recently implemented taxes on sugar-sweetened beverages, but there is relatively little rigorous evidence of their impacts. This paper contributes to our understanding of such taxes by estimating the effects of the beverage tax in Philadelphia, which is of interest because it was the first beverage tax in a large U.S. city (the second such tax in any U.S. city, after Berkeley's). It is also unique in the U.S. in that it taxes diet as well as caloric beverages.

By estimating DiD regressions using hand-collected data from stores in Philadelphia and nearby comparison communities, we find that the tax was fully passed through to consumers via higher retail prices. For all taxed beverages combined, we find in our balanced panel of stores and products that the 1.5 cent-per-ounce tax raised prices by 1.582 cents per ounce, with a 95 percent confidence interval of (1.21, 1.89). The impact of the tax is large, raising prices per ounce by 21 percent on average. Pass-through is complete for specific categories of taxed beverages, such as regular soda (1.591 cents per ounce), diet soda (1.551 cents per ounce), energy drinks (1.998 cents per ounce), and juice drinks (1.928 cents per ounce). Put another way, the incidence of the tax is fully on consumers—they are paying all of it, and retailers, distributors, and manufacturers are paying little if any of it.

This overall estimate of pass-through is higher than estimates for beverage taxes in two other U.S. cities: Berkeley and Boulder. Cawley and Frisvold (2017) and Falbe et al. (2015) estimated that the pass-through of the SSB tax in Berkeley was 40 to 50 percent. The 95 percent confidence intervals in Cawley and Frisvold (2017) rule out that pass-through was complete (100 percent). For Boulder, Cawley et al. (2018b) estimated that 79.3 percent of the two-cents-per-

ounce SSB tax was shifted to consumers in the form of higher prices; the confidence intervals rule out a pass-through of 100 percent. Our results are similar to the only previous estimates from Philadelphia: Cawley et al. (2018a) estimated that prices in taxed stores in the Philadelphia International Airport rose by more than 90 percent of the tax.

Pass-through tends to vary across cities due to factors such as: (1) different price elasticities of demand among residents, (2) differing price elasticities of supply due to different marginal cost curves, (3) differing levels of competitiveness in the markets for retailers and beverage distributors, (4) differences in the ease of cross-border shopping, (5) differences in which beverages are taxed, and (6) differences in the amount of the tax. For example, one potential reason that pass-through is lower in Berkeley than in Philadelphia is that Berkeley is a much smaller city (area of 17.7 mi^2 compared with 141.7 mi^2), so cross-border shopping is easier. As a result, the price elasticity of demand is presumably higher, which limits the ability of retailers to pass the tax on to consumers. Researchers should therefore evaluate other city-level beverage taxes in the U.S. and the national taxes in other countries.

The beverage tax could possibly have spillover effects on the prices of untaxed goods—for example, if consumers substituted untaxed for taxed beverages, shifting the demand for untaxed beverages and raising their price. We find a small increase of the Philadelphia tax on bottled water (29 percent of the tax), but we find a larger increase in the price per ounce of juice (73 percent of the tax).

There is evidence of some interesting heterogeneity in the pass-through of the tax on taxed beverages. Pass-through is higher in independent retailers than in chain stores, which may reflect pricing policies imposed throughout chain locations—i.e., locally owned stores may have greater pricing flexibility than national chains (DellaVigna & Gentzkow, 2017). It is also possible that national chains spread the burden of local taxes across all affiliates to avoid price competition between different locations of their chain.

There is some evidence that pass-through is higher for individual servings of beverages than for large containers or multi-packs; this difference may be due to consumers being less price sensitive for individual servings than for large quantities bought on major shopping trips. Another possible explanation is that the price elasticity of demand differs by size. The cost per ounce tends to fall with size (i.e., there are bulk discounts), so the tax is higher in percentage

terms for a 2-liter bottle than for a 20-ounce bottle; this may result in lower pass-through on larger sizes.

We also find evidence that pass-through is higher in stores that are farther away from untaxed stores outside the city. Stores close to the border may have customers who are more price elastic because it is easier for them to shop across borders. Similarly, Cawley and Frisvold (2017) found that pass-through rose with distance from rival stores that sold untaxed items in Berkeley. More generally, several studies have documented cross-border shopping to avoid other taxes on food (Fisher, 1980; Tosun & Skidmore, 2007).

Our study also provides insight on the regressivity of the Philadelphia tax. First, we find that the incidence of the tax falls entirely on consumers. Second, consumers living in high-poverty neighborhoods face greater price increases in their neighborhood stores because of the tax. Compared with stores at the 25th percentile of the distribution of neighborhood poverty, stores at the 75th percentile raised their prices of regular soda by an extra 0.364 cents per ounce. This increase is equivalent to 24 percent of the amount of the tax. This finding is important because it suggests (without accounting for the incidence of any changes in health or the incidence of the public goods funded by the tax revenues) that the beverage tax could be regressive—not only because it represents a higher percentage of low-income people's incomes but because they face greater price hikes in response to the tax. However, to completely understand the distributional impacts of the tax requires understanding all of its effects, including determining possible changes in health outcomes for individuals with different levels of income and the benefits of the programs funded by the tax revenues.

We also find that, in every Philadelphia store, the tax is included in the shelf or list price (i.e., it is not added at the register). This finding differs from the finding of Cawley et al. (2018b) in Boulder. This is important because one goal of the tax is to reduce consumption, and taxes are more influential when they are more visible or salient (e.g., Chetty et al., 2009).

A novelty of this paper is that we are able to estimate the impact of the tax (and a simultaneous tax credit for stocking untaxed beverages) on the availability of specific types of beverages in stores. We find that larger stores (grocery stores, warehouse stores, and pharmacies), which are not eligible for the tax credit, decrease availability of regular and diet soda and increase the availability of bottled water. Given that grocery stores, warehouse stores,

and pharmacies are ineligible for the tax credit, these changes in availability are presumably due to the beverage tax itself.

The findings of full pass-through (or slightly greater for some beverage types) and changes in the beverages carried by stores are consistent with information gleaned from the interviews we conducted with store owners and managers at 11 stores in Philadelphia 12 to 18 months after the implementation of the tax. Store owners and managers reported that they raised prices by the exact amount of the tax or by the amount distributors raised their prices. In addition, several store owners and managers reported changing the beverages they sold in response to the tax, including carrying more untaxed beverages.

The strengths of this analysis include (1) hand collection of original longitudinal data from a large number of stores; (2) data collection from numerous types of stores, including grocery stores, pharmacies, gas stations, and convenience stores; (3) data collection from both independent stores and national chains; (4) data on a large number of products, both taxed and untaxed; (5) data on stores in nearby comparison communities that are likely to share any unobserved shocks to supply or demand; and (6) relatively long-term follow-up from 10-11 months after the tax.

The limitations of the study include a very limited number of clusters—two geographic areas and two time periods—which makes it difficult to accurately calculate standard errors (Donald & Lang, 2007). However, this limitation is shared by all previous studies of city-level beverage taxes (e.g., Falbe et al., 2015; Cawley & Frisvold, 2017). We also acknowledge the tradeoffs associated with having comparison communities that are near the treated community. Although, an advantage of this proximity is the likelihood that communities will share any unobserved shocks and have parallel trends in the outcomes, a disadvantage is that the tax could lead to cross-border shopping, and the increased demand from Philadelphia shoppers could affect prices and product availability in the nearby areas. We also acknowledge that, although we chose stores in the comparison communities to match the neighborhood demographics of the stores in Philadelphia, they may be imperfect controls. Furthermore, we cannot test whether the trends in prices among the stores in our sample were parallel prior to the tax. However, we observe in the RMS data that, prior to the tax, prices in both the treated and comparison communities followed parallel trends. Finally, we also lack access to information such as the

prices charged by the manufacturer to the distributor, or by the distributor to the retailer, which would enable us to examine the extent to which the tax is borne by either of those parties.

Despite these limitations, this paper contributes substantially to the literature about the impacts of beverage taxes by presenting evidence that the Philadelphia tax—unique in that it taxes diet as well as caloric beverages—was fully passed through to consumers via higher retail prices. Furthermore, pass-through is higher for stores that are farther from rivals selling untaxed beverages; it is also higher in high-poverty neighborhoods, in independent stores versus national chains, and for individual servings versus larger sizes. In addition, Philadelphia retailers ineligible for the tax credit increased the availability of untaxed beverages (particularly bottled water) and reduced the availability of taxed beverages, on average. Such evidence on beverage taxes is important because several U.S. cities and numerous countries around the world have adopted them in recent years, and others (including some U.S. states) are considering implementing similar taxes, yet their effects are far from fully understood. This paper provides valuable, rigorous evidence on the impacts of beverage taxes on retail prices and product availability.

References

Berardi, N., Sevestre, P., Tepaut, M., & Vigneron, A. (2012). The Impact of a "Soda Tax" on Prices: Evidence from French Micro Data (Banque de France Working Paper 415). Paris: Banque de France.

Bergman, U. M., & Hansen, N. L. (2010). Are Excise Taxes on Beverages Fully Passed Through to Prices? The Danish Evidence (Working paper). Retrieved from http://web.econ.ku.dk/okombe/BergmanHansen.pdf.

Cawley, J., & Frisvold, D. E. (2017). The Pass-Through of Taxes on Sugar-Sweetened Beverages to Retail Prices: The Case of Berkeley, California. *Journal of Policy Analysis and Management*, *36*(2), 303–326.

Cawley, J., Willage, B., & Frisvold, D. (2018a). Pass-Through of a Tax on Sugar-Sweetened Beverages at the Philadelphia International Airport. *Journal of the American Medical Association*, *319*(3), 305–306.

Cawley, J., Crain, C., Frisvold, D. E., & Jones, D. (2018b). The Pass-Through of the Largest Tax on Sugar-Sweetened Beverages: The Case of Boulder, Colorado (Working paper).

Chetty, R., Looney, A., & Kroft, K. (2009). Salience and Taxation: Theory and Evidence. *American Economic Review*, *99*(4), 1145–1177.

DellaVigna, S., & Gentzkow, M. (2017). Uniform Pricing in U.S. Retail Chains (NBER Working Paper 23996). Cambridge, MA: National Bureau of Economic Research.

Donald, S. G., & Lang, K. (2007). Inference with Difference-in-Differences and Other Panel Data. *Review of Economics and Statistics*, *89*, 221–233.

Falbe, J., Rojas, N., Grummon, A. H., & Madsen, K. A. (2015). Higher Retail Prices of Sugar-Sweetened Beverages 3 Months After Implementation of an Excise Tax in Berkeley, California. *American Journal of Public Health*, *105*, 2194–2201.

Fisher, R. C. (1980). Local Sales Taxes: Tax Rate Differentials, Sales Loss, and Revenue Estimation. *Public Finance Review*, *8*, 171–188.

Fryar, C.D., Carroll, M.D., & Ogden, C.L. (2016). Prevalence of Overweight, Obesity, and Extreme Obesity Among Adults Aged 20 and Over: United States, 1960–1962 Through 2013–2014. National Center for Health Statistics Health E-Stats. July.

Fullerton, D., & Metcalf, G. E. (2002). Tax Incidence. In A. Auerbach & M. Feldstein (Eds.), Handbook of Public Economics, vol. 4. Amsterdam: Elsevier.

Grogger, J. (2015). Soda Taxes and the Prices of Sodas and Other Drinks: Evidence from Mexico. NBER Working Paper # 21197.

Hales C., Carroll M., Fryar C., Ogden C. (2017) Prevalence of obesity among adults and youth: United States, 2015–2016. NCHS data brief, no 288. Hyattsville, MD: National Center for Health Statistics.

Hill, J.O., Galloway, J.M., Goley, A., Marrero, D.G., Minners, R. et al. (2013). Scientific Statement: Socioecological Determinants of Prediabetes and Type 2 Diabetes. Diabetes Care, 36: 2430-2439.

Kotlikoff, L. J., & Summers, L. H. (1987). Tax Incidence. In A. Auerbach & M. Feldstein (Eds.), *Handbook of Public Economics*, vol. 2. Amsterdam: Elsevier.

Lin, Biing-Hwan, Travis A. Smith, Jonq-Ying Lee, Kevin D. Hall. 2011. Measuring weight outcomes for obesity intervention strategies: The case of a sugar-sweetened beverage tax. *Economics & Human Biology*, 9(4): 329-341.

Malik, V. S., & Hu, F. B. (2011). Sugar-Sweetened Beverages and Health: Where Does the Evidence Stand? *American Journal of Clinical Nutrition, 94*, 1161–1162.

NCD Risk Factor Collaboration. (2016). Trends in Adult Body-Mass Index in 200 Countries from 1975 to 2014: A Pooled Analysis of 1,698 Population-Based Measurement Studies with 19.2 Million Participants. *Lancet, 387*, 1377–1396.

Powell, L. M., Chriqui, J. F., Khan, T., Wada, R., & Chaloupka, F. J. (2013). 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 Reviews, 14*, 110–128.

Tosun, M. S., & Skidmore, M. L. (2007). Cross-Border Shopping and the Sales Tax: An Examination of Food Purchases in West Virginia. *The B.E. Journal of Economic Analysis & Policy*, *7*(1), Article 63.

Thow AM, Downs SM, Mayes C, Trevena H, Waqanivalu T, Cawley J. (2018). Fiscal policy to improve diets and prevent noncommunicable diseases: from recommendations to action. Bulletin of the World Health Organization. 96: 01-210.

United States Census Bureau. (2017). QuickFacts: Philadelphia County, Pennsylvania. Retrieved from https://www.census.gov/quickfacts/fact/table/philadelphiacountypennsylvania/PST045217.

Weyl, E., & M. Fabinger. (2013). Pass-Through as an Economic Tool: Principles of Incidence Under Imperfect Competition. *Journal of Political Economy*, *121*(3): 528–583.

Table 1: Average Price per Ounce of Beverages Before and After the Implementation of the SSB Tax in Philadelphia

	Stores in Philadelphia			Comparison Stores		
	2016	2017	Difference	2016	2017	Difference
Taxed Beverages	7.474 (0.203) [1,253]	9.332 (0.226) [1,052]	1.859 (0.303) [2,305]	7.865 (0.200) [1,562]	8.257 (0.207) [1,366]	0.392 (0.288) [2,928]
SSB	7.083 (0.231) [830]	8.906 (0.258) [714]	1.823 (0.345) [1,544]	7.431 (0.222) [1,012]	7.835 (0.241) [907]	0.404 (0.327) [1,919]
Regular Soda	5.218 (0.114) [580]	7.125 (0.137) [502]	1.907 (0.177) [1,082]	5.393 (0.108) [689]	5.712 (0.118) [618]	0.318 (0.160) [1,307]
Sports Drink	6.914 (0.243) [93]	8.479 (0.310) [77]	1.565 (0.389) [170]	6.912 (0.237) [117]	7.027 (0.249) [87]	0.114 (0.348) [204]
Energy Drink	26.933 (0.480) [125]	28.662 (0.512) [107]	1.729 (0.703) [232]	27.202 (0.642) [175]	26.769 (0.424) [165]	-0.432 (0.779) [340]
Juice Drink	5.022 (0.458) [43]	6.191 (0.572) [44]	1.169 (0.734) [87]	5.082 (0.441) [60]	5.529 (0.564) [58]	0.448 (0.713) [118]
Sweet Tea	4.629 (0.229) [96]	5.199 (0.264) [64]	0.570 (0.354) [160]	4.650 (0.216) [126]	4.209 (0.217) [92]	-0.441 (0.313) [218]
Diet Soda	5.279 (0.159) [316]	7.426 (0.193) [258]	2.147 (0.248) [574]	5.340 (0.143) [395]	5.819 (0.158) [346]	0.479 (0.213) [741]
Untaxed Beverages	8.718 (0.402) [134]	9.061 (0.404) [158]	0.343 (0.574) [292]	8.025 (0.318) [203]	8.449 (0.344) [187]	0.424 (0.468) [390]
Water	5.581 (0.456) [57]	6.029 (0.437) [78]	0.448 (0.643) [135]	5.736 (0.332) [111]	5.854 (0.373) [95]	0.118 (0.498) [206]
Juice	11.041	12.018	0.977	10.786	11.128	0.343

	(0.461)	(0.485)	(0.670)	(0.425)	(0.433)	(0.607)
	[77]	[80]	[157]	[92]	[92]	[184]

Notes: This table shows the mean price per ounce among all beverages for the listed categories. Standard errors are in parentheses, and sample sizes are in brackets. The sample sizes are store-beverage combinations. In Philadelphia, there were 66 stores in November and December 2016 and 64 stores in November and December 2017. In the Philadelphia MSA, there were 78 comparison stores in November and December 2016 and 74 stores in November and December 2017. Taxed beverages include SSBs and diet soda. SSBs include regular soda, sports drinks, energy drinks, juice drinks (containing less than 50 percent juice), and sweetened tea. Untaxed beverages include water and juice.

Table 2: The Impact of the SSB Tax on Prices

	Full Sample	Balanced Sample
All Taxed Beverages	1.558	1.582
	(0.172)	(0.183)
	[5,233]	[4,022]
SSB	1.512	1.520
	(0.168)	(0.172)
	[3,463]	[2,696]
Regular Soda	1.552	1.591
	(0.126)	(0.119)
	[2,389]	[1,956]
Sports Drink	1.450	1.267
	(0.299)	(0.197)
	[374]	[274]
Energy Drink	2.071	1.998
	(1.089)	(1.342)
	[572]	[442]
Juice Drink	1.788	1.928
	(0.490)	(0.600)
	[205]	[88]
Sweet Tea	0.900	1.038
	(0.279)	(0.265)
	[378]	[208]
Diet Soda	1.588	1.551
	(0.128)	(0.124)
	[1,315]	[1,054]
Untaxed Beverages	0.598	0.759
	(0.259)	(0.252)
	[682]	[482]
Water	0.339	0.434
	(0.234)	(0.217)
	[341]	[252]
Juice	0.950	1.089
	(0.435)	(0.496)
	[341]	[230]

Notes: This table shows the DiD estimates in cents per ounce (full pass-through is 1.5 cents per ounce) for the product category in the row heading and the sample of stores in the column heading. Standard errors, which are robust to clustering at the store level, are in parentheses, and sample sizes are in brackets. The sample sizes are store-beverage combinations. Each cell contains the results from a separate regression. Additional variables that are included, but not shown, are a binary variable indicating that the store is located in Philadelphia, a binary variable indicating that the price is from after implementation of the tax, store type indicators, and product fixed effects.

Table 3: The Impact of the SSB Tax on Product Availability

	Full Sample	Store Types not Eligible for Tax Credit	Store Types Eligible for Tax Credit
All Taxed Beverages	-0.043	-0.041	-0.050
	(0.026)	(0.028)	(0.061)
	[10,488]	[7,904]	[2,584]
SSB	-0.046	-0.045	-0.051
	(0.029)	(0.033)	(0.064)
	[6,348]	[4,784]	[1,564]
Regular Soda	-0.058	-0.074	-0.010
	(0.039)	(0.043)	(0.086)
	[3,312]	[2,496]	[816]
Sports Drinks	0.017	0.024	-0.014
	(0.036)	(0.043)	(0.129)
	[1,104]	[832]	[272]
Energy Drinks	-0.071	-0.059	-0.108
	(0.049)	(0.054)	(0.113)
	[1,104]	[832]	[272]
Juice Drinks	0.004	0.047	-0.126
	(0.043)	(0.049)	(0.083)
	[1,104]	[832]	[272]
Sweet Tea	-0.021	-0.008	-0.076
	(0.040)	(0.047)	(0.079)
	[1,656]	[1,248]	[408]
Diet Soda	-0.070	-0.083	-0.029
	(0.039)	(0.042)	(0.092)
	[2,208]	[1,664]	[544]
Untaxed Beverages	0.052	0.062	0.022
	(0.029)	(0.034)	(0.069)
	[2,208]	[1,664]	[272]
Water	0.109	0.103	0.121
	(0.041)	(0.048)	(0.080)
	[1,104]	[832]	[272]
Juice	-0.005	0.021	-0.110

	(0.042)	(0.049)	(0.113)
	[1,104]	[832]	[272]

Notes: The results represent the average percentage point change in the availability of beverages in Philadelphia within the given beverage type compared to the comparison stores. Standard errors, which are robust to clustering at the store level, are in parentheses, and sample sizes are in brackets. The sample sizes are store-beverage combinations. Each cell contains the results from a separate regression. Additional variables that are included, but not shown, are a binary variable indicating that the store is located in Philadelphia, a binary variable indicating that the product availability is measured after implementation of the tax, store type indicators, and product fixed effects. Stores eligible for the tax credit include convenience stores and gas stations with convenience stores. Stores not eligible for the tax credit include grocery stores, warehouse stores, and pharmacies.

Table 4: Variation in Pass-Through Estimates by Store Type

	Large Grocery Store (reference category)	Warehouse Store	Pharmacy	Small Grocery Store	Convenience Store	Gas Station
All Taxed Beverages	1.179 (0.328) [4,022]	1.027 (0.876)	-0.296 (0.482)	0.769 (0.413)	0.126 (0.565)	1.593 (0.519)
Regular Soda	1.568 (0.147) [1,956]	0.340 (0.243)	-0.567 (0.345)	0.230 (0.222)	-0.251 (0.411)	0.875 (0.441)
Diet Soda	1.525 (0.132) [1,054]	0.612 (0.298)	-0.475 (0.301)	0.129 (0.174)	-0.259 (0.409)	0.605 (0.399)

Notes: The values in the column for large grocery stores are the impacts on prices for large grocery stores, which is the comparison group for the other columns. The values in the other columns represent the differential impact for the store type compared to large grocery stores, estimated as the interaction between the store type indicators and the differences-in-differences interaction term. Standard errors, which are robust to clustering at the store level, are in parentheses, and sample sizes are in brackets. The sample sizes are store-beverage combinations. Each row contains the results from a separate regression for the specified beverage category. Additional variables that are included, but not shown, are a binary variable indicating that the store is located in Philadelphia, a binary variable indicating that the price is from after implementation of the tax, store type indicators, and product fixed effects.

Table 5: Variation in Pass-Through Estimates for Chain Stores

	Independent Retailers (reference category)	Chain Stores
All Taxed Beverages	2.107	-0.815
	(0.184)	(0.307)
	[4,022]	
Regular Soda	1.986	-0.634
	(0.148)	(0.222)
	[1,956]	
Diet Soda	1.795	-0.315
	(0.154)	(0.222)
	[1,054]	

Notes: The values in the column for independent retailers are the impacts on prices for independent retail stores, which is the comparison group for the results for chain stores. The values in the column for chain stores represent the differential impacts for stores that are branches of larger chains compared to the independent retailers, estimated as the interaction between the chain store indicator and the differences-in-differences interaction term. Standard errors, which are robust to clustering at the store level, are in parentheses, and sample sizes are in brackets. The sample sizes are store-beverage combinations. Each row contains the results from a separate regression for the specified beverage category. Additional variables that are included, but not shown, are a binary variable indicating that the store is located in Philadelphia, a binary variable indicating that the price is from after implementation of the tax, store type indicators, and product fixed effects.

Table 6: Variation in Pass-Through Estimates by Container Size

	Small Single-Serving Containers (reference category)	Large Containers	Multi-Packs
All Taxed Beverages	1.731 (0.315) [4,022]	-0.327 (0.316)	-0.263 (0.378)
Regular Soda	1.817 (0.168) [1,956]	-0.430 (0.190)	-0.512 (0.212)
Diet Soda	1.647 (0.166) [1,054]	-0.166 (0.258)	-0.216 (0.194)

Notes: The values in the column for small single-serving containers are the impacts on prices for small containers sizes, which is the comparison group for the other columns. The values in the other columns represent the differential impact for the container sizes compared to the small single-serving sizes. The small single-serving size includes containers holding up to 23 ounces; large containers include containers holding 59 ounces and greater; and multi-packs include anything other than single-serving sizes and large containers. Standard errors, which are robust to clustering at the store level, are in parentheses, and sample sizes are in brackets. The sample sizes are store-beverage combinations. Each row contains the results from a separate regression for the specified beverage category. Additional variables that are included, but not shown, are a binary variable indicating that the store is located in Philadelphia, a binary variable indicating that the price is from after implementation of the tax, store type indicators, and product fixed effects.

Table 7: Variation in Pass-Through Estimates by Travel Time to the Closest Competitor Outside of the City

	Full Sample	Large Stores	Small Stores
All Taxed Beverages			
Philadelphia x 2017	1.587	1.571	1.607
	(0.176)	(0.326)	(0.206)
Phil. x 2017 x Time	0.073	0.078	0.067
	(0.030)	(0.044)	(0.038)
Observations	4,022	1,418	2,604
Regular Soda			
Philadelphia x 2017	1.590	1.729	1.524
	(0.114)	(0.128)	(0.157)
Phil. x 2017 x Time	0.051	0.044	0.054
	(0.026)	(0.023)	(0.033)
Observations	1,956	616	1,340
Diet Soda			
Philadelphia x 2017	1.554	1.768	1.407
	(0.120)	(0.152)	(0.163)
Phil. x 2017 x Time	0.013	-0.021	0.030
	(0.024)	(0.037)	(0.029)
Observations	1,054	404	650

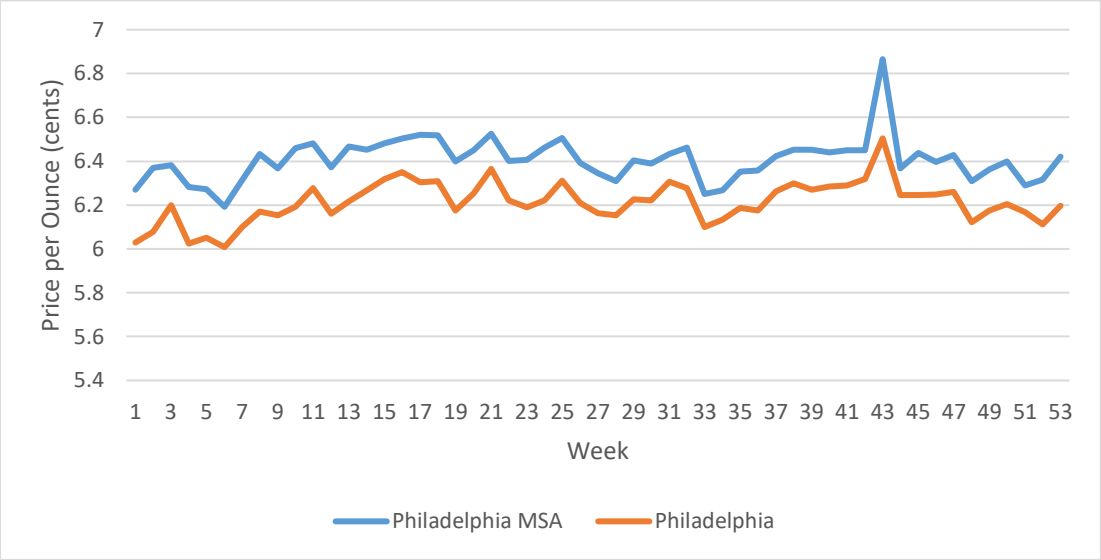
Notes: The triple interaction represents the change in the DiD estimate for a one-minute increase in the travel time between stores and the closest competitor. Given that time is centered at the mean, Philadelphia x 2017 is estimated at the mean travel time to the closest competitor outside of Philadelphia for Philadelphia stores in the sample, which is 12.046 minutes for all stores. Standard errors, which are robust to clustering at the store level, are in parentheses. The sample sizes are store-beverage combinations. Additional variables that are included, but not shown, are a binary variable indicating that the store is located in Philadelphia, a binary variable indicating that the price is from after implementation of the tax, store type indicators, and product fixed effects. Large stores include large grocery and warehouse stores. Small stores include stand-alone convenience stores, gas stations with convenience stores, small grocery stores, and pharmacies.

Table 8: Variation in Pass-Through Estimates by Local Population Characteristics

	Percentage of Households in Poverty	Percentage of Population African-American	Percentage of Population Hispanic
All Taxed Beverages			
Philadelphia x 2017	1.544	1.441	1.531
	(0.222)	(0.246)	(0.226)
Phil. x 2017 x Population Characteristic	0.112	-0.015	0.080
	(0.148)	(0.074)	(0.143)
Observations	4,022	4,022	4,022
Regular Soda			
Philadelphia x 2017	1.516	1.453	1.542
	(0.147)	(0.160)	(0.148)
Phil. x 2017 x Population Characteristic	0.226	0.039	0.047
	(0.109)	(0.064)	(0.071)
Observations	1,956	1,956	1,956
Diet Soda			
Philadelphia x 2017	1.395	1.456	1.444
	(0.128)	(0.120)	(0.118)
Phil. x 2017 x Population Characteristic	0.210	0.061	0.024
	(0.099)	(0.055)	(0.070)
Observations	1,054	1,054	1,054

Notes: The triple interaction represents the change in the DiD estimate for an increase of 10 percentage points in the local population characteristic. Given that each local population characteristic is centered at the mean, Philadelphia x 2017 is estimated at the mean value among stores in the sample. The mean percentage of households in poverty is 27.2 percent. The mean percentage African-American is 40.0 percent. The mean percentage Hispanic is 23.2 percent. Standard errors, which are robust to clustering at the store level, are in parentheses. The sample sizes are store-beverage combinations. Additional variables that are included, but not shown, are a binary variable indicating that the store is located in Philadelphia, a binary variable indicating that the price is from after implementation of the tax, store type indicators, and product fixed effects.

Appendix Figure 1: Average Weekly Price per Ounce of Regular Soda, Diet Soda, and Juice Drinks in 2016



Notes: This figure shows the average weekly price per ounce of regular soda, diet soda, and juice drinks in retail stores in Philadelphia and in the Philadelphia MSA throughout 2016. The conclusions drawn from the Nielsen data are those of the researchers and do not reflect the views of Nielsen. Nielsen is not responsible for, had no role in, and was not involved in analyzing and preparing the results reported herein.
Source: Researcher(s) own analyses calculated (or derived) based in part on data from The Nielsen Company (US), LLC and marketing databases provided through the Nielsen Datasets at the Kilts Center for Marketing Data Center at The University of Chicago Booth School of Business.

Appendix Figure 2: Distribution of Price per Ounce for All Taxable Beverages Before and After Implementation of the SSB Tax

Notes: These figures show the distributions of the price per ounce of taxable beverages in stores located in Philadelphia and in the comparison stores located in the Philadelphia MSA prior to the tax (the left figure) and after the implementation of the tax (the right figure). The figure excludes energy drinks because of their high price per ounce and thus helps highlight the distributions for all other taxable beverages.

Appendix Table 1: Average Price per Ounce of Beverages Before and After the Implementation of the SSB Tax in Philadelphia for All Products

	Philadelphia			Comparison Stores		
	2016	2017	Difference	2016	2017	Difference
Taxed Beverages						
7-Up, 20 ounces	7.773	9.840	2.068	8.793	8.911	0.118
	(0.290)	(0.249)	(0.394)	(0.196)	(0.230)	(0.301)
	[33]	[26]	[59]	[35]	[32]	[67]
7-up, 2 liter	2.790	3.887	1.097	2.974	3.061	0.087
	(0.186)	(0.160)	(0.254)	(0.166)	(0.072)	(0.187)
	[40]	[31]	[71]	[44]	[40]	[84]
Arizona Iced Tea, 1 gallon	2.408	3.845	1.437	2.324	2.437	0.113
	(0.086)	(0.166)	(0.184)	(0.103)	(0.081)	(0.134)
	[21]	[20]	[41]	[28]	[24]	[52]
Arizona Iced Tea, 23 ounces	4.301	5.178	0.877	4.298	4.535	0.237
	(0.090)	(0.329)	(0.267)	(0.056)	(0.204)	(0.204)
	[42]	[22]	[64]	[48]	[44]	[92]
Coke Zero, 20 ounces	8.946	10.862	1.916	8.965	9.317	0.352
	(0.222)	(0.189)	(0.291)	(0.142)	(0.173)	(0.223)
	[28]	[29]	[57]	[37]	[36]	[73]
Coke Zero, 2 liter	2.766	4.780	2.014	2.860	3.088	0.228
	(0.153)	(0.365)	(0.349)	(0.086)	(0.078)	(0.120)
	[26]	[17]	[43]	[31]	[23]	[54]
Coke, 12-pack	3.670	5.079	1.409	3.675	3.930	0.255
	(0.118)	(0.184)	(0.216)	(0.083)	(0.077)	(0.116)
	[30]	[28]	[58]	[55]	[44]	[99]
Coke, 20 ounces	8.086	10.188	2.102	8.582	8.864	0.283
	(0.207)	(0.172)	(0.270)	(0.141)	(0.149)	(0.205)
	[57]	[56]	[113]	[65]	[63]	[128]
Coke, 2 liter	2.944	4.353	1.410	2.966	3.115	0.150
	(0.072)	(0.082)	(0.109)	(0.055)	(0.061)	(0.082)
	[56]	[48]	[104]	[67]	[62]	[129]
Diet Arizona Iced Tea, 15.5 ounces	7.102	6.419	-0.683	6.402	6.387	-0.015
	(0.466)	(3.194)	(1.545)	(0.008)	(0.000)	(0.021)
	[12]	[2]	[14]	[13]	[2]	[15]
Diet Arizona Iced Tea, 1 gallon	2.444	4.002	1.557	1.942	2.540	0.598
	(0.189)	(0.260)	(0.328)	(0.192)	(0.168)	(0.264)
	[8]	[9]	[17]	[13]	[10]	[23]
Diet Coke, 12-pack 12 ounces	3.786	5.228	1.442	3.587	3.876	0.290
	(0.100)	(0.247)	(0.244)	(0.102)	(0.076)	(0.130)
	[26]	[20]	[46]	[46]	[42]	[88]
Diet Coke, 20 ounces	8.175	10.541	2.366	8.683	9.000	0.317
	(0.224)	(0.184)	(0.295)	(0.152)	(0.150)	(0.214)

	[50]	[43]	[93]	[58]	[57]	[115]
Diet Coke, 2 liter	2.860	4.386	1.526	2.959	3.260	0.301
	(0.093)	(0.087)	(0.132)	(0.058)	(0.154)	(0.152)
	[47]	[34]	[81]	[57]	[45]	[102]
Diet Lipton Iced Tea, 20 ounces	9.188	7.463	-1.725	8.444	8.700	0.256
	(0.440)	(1.000)	(1.093)	(0.389)	(1.315)	(1.019)
	[4]	[4]	[8]	[9]	[4]	[13]
Diet Pepsi, 12-pack 12 ounces	3.455	5.081	1.626	3.454	3.716	0.262
	(0.155)	(0.190)	(0.244)	(0.120)	(0.071)	(0.145)
	[31]	[22]	[53]	[48]	[42]	[90]
Diet Pepsi, 20 ounces	7.961	9.958	1.997	8.552	8.854	0.302
	(0.210)	(0.200)	(0.290)	(0.164)	(0.170)	(0.237)
	[57]	[54]	[111]	[60]	[55]	[115]
Diet Pepsi, 2 liter	2.806	4.183	1.377	2.979	3.071	0.092
	(0.095)	(0.128)	(0.156)	(0.097)	(0.136)	(0.163)
	[51]	[39]	[90]	[58]	[46]	[104]
Red Bull Sugar Free, 4-pack 8.4 ounces	23.697	24.747	1.050	22.342	22.788	0.447
	(1.159)	(1.542)	(1.952)	(0.806)	(0.563)	(0.963)
	[13]	[14]	[27]	[25]	[29]	[54]
Red Bull Sugar Free, 8.4 ounces	29.101	30.283	1.182	30.766	29.096	-1.670
	(0.847)	(0.828)	(1.202)	(1.578)	(0.583)	(1.813)
	[40]	[32]	[72]	[53]	[44]	[97]
Gatorade G2, 20 ounces	8.415	10.661	2.246	8.554	8.371	-0.183
	(0.273)	(0.960)	(0.752)	(0.232)	(0.283)	(0.397)
	[20]	[9]	[29]	[27]	[12]	[39]
Gatorade G2, 8-pack 20 ounces	3.534	5.253	1.719	3.388	3.751	0.364
	(0.246)	(0.393)	(0.464)	(0.275)	(0.166)	(0.342)
	[10]	[10]	[20]	[15]	[12]	[27]
Gatorade, 20 ounces	7.895	9.580	1.685	8.168	8.367	0.199
	(0.200)	(0.230)	(0.304)	(0.192)	(0.152)	(0.250)
	[50]	[47]	[97]	[57]	[50]	[107]
Gatorade, 8-pack 20 ounces	3.431	4.923	1.492	3.412	3.654	0.243
	(0.231)	(0.485)	(0.511)	(0.251)	(0.181)	(0.334)
	[13]	[11]	[24]	[18]	[13]	[31]
Hawaiian Punch, 1 gallon	2.110	2.829	0.719	2.122	1.919	-0.203
	(0.149)	(0.175)	(0.233)	(0.143)	(0.122)	(0.192)
	[14]	[16]	[30]	[19]	[16]	[35]
Hawaiian Punch, 20- ounces	6.753	9.967	3.214	8.321	9.591	1.270
	(0.398)	(0.963)	(0.889)	(1.002)	(1.835)	(2.043)
	[16]	[9]	[25]	[12]	[11]	[23]
Minute Maid Lemonade, 20 ounces	9.164	10.195	1.031	8.009	8.294	0.285
	(0.360)	(0.525)	(0.700)	(0.414)	(0.434)	(0.601)
	[7]	[10]	[17]	[16]	[17]	[33]
Minute Maid Lemonade, 2 liter	2.369	3.945	1.575	2.815	3.108	0.292
	(0.254)	(0.246)	(0.367)	(0.288)	(0.360)	(0.465)
	[6]	[9]	[15]	[13]	[14]	[27]

Lipton Iced Tea, 20 ounces	7.956 (0.595) [9]	9.029 (0.449) [7]	1.073 (0.785) [16]	8.673 (0.417) [15]	7.031 (0.673) [8]	-1.642 (0.752) [23]
Mountain Dew, 20 ounces	7.718 (0.239) [58]	9.909 (0.216) [52]	2.191 (0.325) [110]	8.535 (0.160) [61]	8.666 (0.185) [58]	0.131 (0.244) [119]
Mountain Dew, 2 liter	2.871 (0.085) [53]	4.169 (0.126) [39]	1.298 (0.147) [92]	2.882 (0.071) [57]	3.011 (0.080) [51]	0.129 (0.106) [108]
Pepsi,12-pack 12-ounces	3.460 (0.160) [34]	4.860 (0.257) [24]	1.400 (0.287) [58]	3.552 (0.094) [51]	3.676 (0.078) [44]	0.124 (0.124) [95]
Pepsi, 20 ounces	7.891 (0.207) [61]	9.884 (0.181) [58]	1.993 (0.276) [119]	8.476 (0.155) [65]	8.793 (0.165) [60]	0.317 (0.226) [125]
Pepsi, 2 liter	2.774 (0.089) [57]	4.126 (0.124) [45]	1.353 (0.149) [102]	2.888 (0.066) [66]	3.050 (0.080) [54]	0.162 (0.103) [120]
Red Bull, 4-pack 8.4 ounces	23.238 (0.912) [19]	25.232 (1.516) [15]	1.994 (1.691) [34]	22.438 (0.736) [28]	22.746 (0.520) [33]	0.308 (0.882) [61]
Red Bull, 8.4 ounces	27.415 (0.705) [53]	29.845 (0.636) [46]	2.430 (0.961) [99]	28.157 (0.792) [69]	29.241 (0.779) [59]	1.084 (1.119) [128]
Sprite, 20 ounces	8.019 (0.221) [53]	10.279 (0.189) [52]	2.260 (0.291) [105]	8.526 (0.160) [62]	8.883 (0.152) [60]	0.358 (0.220) [122]
Sprite, 2 liter	2.931 (0.085) [48]	4.438 (0.160) [43]	1.506 (0.176) [91]	2.994 (0.055) [61]	3.092 (0.065) [50]	0.098 (0.084) [111]
Untaxed Beverages						
Apple Juice, 10-pack boxes	5.917 (0.364) [7]	6.386 (0.432) [7]	0.469 (0.565) [14]	5.805 (0.212) [10]	6.100 (0.201) [8]	0.295 (0.298) [18]
Apple Juice, 15.2 ounces	12.189 (0.934) [15]	12.697 (0.252) [16]	0.509 (0.940) [31]	11.896 (0.327) [16]	12.486 (0.311) [19]	0.591 (0.453) [35]
Aquafina, 20 ounces	7.933 (0.349) [18]	8.490 (0.362) [25]	0.557 (0.520) [43]	8.131 (0.220) [37]	8.172 (0.261) [29]	0.041 (0.339) [66]
Aquafina, 24-pack 16.9 ounces	1.297 (0.048) [11]	1.267 (0.048) [16]	-0.031 (0.070) [27]	1.306 (0.035) [21]	1.309 (0.046) [20]	0.003 (0.057) [41]
Dasani, 20 ounces	7.905	8.610	0.704	8.143	8.614	0.471

	(0.379)	(0.445)	(0.614)	(0.286)	(0.279)	(0.401)
	[19]	[26]	[45]	[35]	[32]	[67]
Dasani,	1.203	1.260	0.057	1.302	1.236	-0.066
24-pack 16.9	(0.043)	(0.047)	(0.065)	(0.061)	(0.052)	(0.083)
ounces	[9]	[11]	[20]	[18]	[14]	[32]
Tropicana 100%	14.220	16.044	1.824	15.113	15.351	0.238
Orange Juice,	(0.464)	(0.514)	(0.694)	(0.359)	(0.356)	(0.506)
12 ounces	[31]	[32]	[63]	[33]	[33]	[66]
Tropicana 100%	7.712	8.008	0.296	7.429	7.225	-0.205
Orange Juice,	(0.355)	(0.292)	(0.458)	(0.295)	(0.295)	(0.417)
59 ounces	[24]	[25]	[49]	[33]	[32]	[65]

Notes: See Table 1.

Appendix Table 2: Variation in Pass-Through Estimates by Travel Distance to the Closest Competitor Outside of the City

	Full Sample	Large Stores	Small Stores
All Taxed Beverages			
Philadelphia x 2017	1.585	1.476	1.666
	(0.179)	(0.359)	(0.194)
Phil. x 2017 x Distance	0.217	0.216	0.288
	(0.120)	(0.170)	(0.178)
	[4,022]	[1,418]	[2,604]
Regular Soda			
Philadelphia x 2017	1.598	1.664	1.577
	(0.110)	(0.128)	(0.141)
Phil. x 2017 x Distance	0.224	0.178	0.254
	(0.106)	(0.094)	(0.161)
	[1,956]	[616]	[1,340]
Diet Soda			
Philadelphia x 2017	1.553	1.781	1.433
	(0.122)	(0.187)	(0.150)
Phil. x 2017 x Distance	0.085	-0.016	0.151
	(0.104)	(0.134)	(0.153)
	[1,054]	[404]	[650]

Notes: The triple interaction represents the change in the DiD estimate for a one-mile increase in the travel time between stores and the closest competitor. Given that distance is centered at the mean, Philadelphia x 2017 is estimated at the mean travel distance to the closest competitor outside of Philadelphia for Philadelphia stores in the sample, which is 3.23 miles. Standard errors, which are robust to clustering at the store level, are in parentheses. The sample sizes are store-beverage combinations. Additional variables that are included, but not shown, are a binary variable indicating that the store is located in Philadelphia, a binary variable indicating that the price is from after implementation of the tax, store type indicators, and product fixed effects. Large stores include large grocery and warehouse stores. Small stores include stand-alone convenience stores, gas stations with convenience stores, small grocery stores, and pharmacies.

Appendix Table 3: Variation in Pass-Through Estimates by Distance to the City Border

	Full Sample	Large Stores	Small Stores
All Taxed Beverages			
Philadelphia x 2017	1.716	1.860	1.450
	(0.272)	(0.444)	(0.277)
Phil. x 2017 x Distance	0.585	-0.152	0.754
	(0.227)	(0.317)	(0.295)
	[4,022]	[1,418]	[2,604]
Regular Soda			
Philadelphia x 2017	1.545	1.714	1.358
	(0.123)	(0.142)	(0.159)
Phil. x 2017 x Distance	0.432	-0.108	0.704
	(0.209)	(0.222)	(0.254)
	[1,956]	[616]	[1,340]
Diet Soda			
Philadelphia x 2017	1.552	1.770	1.324
	(0.123)	(0.175)	(0.169)
Phil. x 2017 x Distance	0.181	-0.160	0.459
	(0.200)	(0.145)	(0.276)
	[1,054]	[404]	[650]

Notes: The triple interaction represents the change in the DiD estimate for a one-mile increase in the distance between stores and the city border. Given that distance is centered at the mean, Philadelphia x 2017 is estimated at the mean travel distance to the border for Philadelphia stores in the sample, which is 1.43 miles. Standard errors, which are robust to clustering at the store level, are in parentheses. The sample sizes are store-beverage combinations. Additional variables that are included, but not shown, are a binary variable indicating that the store is located in Philadelphia, a binary variable indicating that the price is from after implementation of the tax, store type indicators, and product fixed effects. Large stores include large grocery and warehouse stores. Small stores include stand-alone convenience stores, gas stations with convenience stores, small grocery stores, and pharmacies.

Appendix Table 4: Variation in Estimates on Product Availability for Chain Stores

	Independent Retailers (reference category)	Chain Stores
All Taxed Beverages	-0.055 (0.033) [10,488]	0.022 (0.050)
Regular Soda	-0.068 (0.055) [3,312]	0.015 (0.077)
Diet Soda	-0.067 (0.051) [2,208]	-0.007 (0.078)
All Untaxed Beverages	0.019 (0.042) [2,208]	0.060 (0.057)
Bottled Water	0.096 (0.051) [1,104]	0.022 (0.081)

Notes: The values in the column for independent retailers are the impacts on availability for independent retail stores, which is the comparison group for the results for chain stores. The values in the column for chain stores represent the differential impacts for stores that are branches of larger chains compared to the independent retailers, estimated as the interaction between the chain store indicator and the differences-in-differences interaction term. Standard errors, which are robust to clustering at the store level, are in parentheses, and sample sizes are in brackets. The sample sizes are store-beverage combinations. Each row contains the results of separate regressions for the specified beverage category. Additional variables that are included, but not shown, are a binary variable indicating that the store is located in Philadelphia, a binary variable indicating that the product availability is measured after implementation of the tax, store type indicators, and product fixed effects.

Appendix Table 5: Variation in Estimates on Product Availability by Container Size

	Small Single-Serving Container (reference category)	Large Container	Multi-Packs
All Taxed Beverages	-0.073 (0.038) [10,488]	0.060 (0.103)	0.057 (0.110)
Regular Soda	-0.072 (0.054) [3,312]	0.073 (0.131)	0.039 (0.136)
Diet Soda	-0.058 (0.061) [2,208]	-0.016 (0.154)	-0.059 (0.138)
All Untaxed Beverages	0.007 (0.047) [2,208]	0.078 (0.105)	0.202 (0.175)
Bottled Water	0.094 (0.058) [1,104]	0.023 (0.137)	0.156 (0.256)

Notes: The values in the column for small single-serving containers are the impacts on prices for small container sizes, which is the comparison group for the other columns. The values in the other columns represent the differential impact for the container sizes compared to the small single-serving sizes. Small single-serving sizes include containers holding up to 23 ounces; large containers include containers holding 59 ounces and greater; and multi-packs include anything other than individual serving-size containers. Standard errors, which are robust to clustering at the store level, are in parentheses, and sample sizes are in brackets. The sample sizes are store-beverage combinations. Each row contains the results of separate regressions for the specified beverage category. Additional variables that are included, but not shown, are a binary variable indicating that the store is located in Philadelphia, a binary variable indicating that the price is from after implementation of the tax, store type indicators, and product fixed effects.

Appendix Table 6: Variation in Estimates on Product Availability by Travel Time to the Closest Competitor Outside of the City

	Full Sample
All Taxed Beverages	
Philadelphia x 2017	-0.043
	(0.025)
Philadelphia x 2017 x Time	-0.001
	(0.004)
Observations	10,488
Regular Soda	
Philadelphia x 2017	-0.056
	(0.038)
Philadelphia x 2017 x Time	-0.003
	(0.007)
Observations	3,312
Diet Soda	
Philadelphia x 2017	-0.067
	(0.038)
Philadelphia x 2017 x Time	0.007
	(0.007)
Observations	2,208
All Untaxed Beverages	
Philadelphia x 2017	0.054
	(0.028)
Philadelphia x 2017 x Time	0.007
	(0.005)
Observations	2,208
Bottled Water	
Philadelphia x 2017	0.112
	(0.040)
Philadelphia x 2017 x Time	0.006
	(0.080)
Observations	1,104

Notes: The triple interaction represents the change in the DiD estimate for a one-minute increase in the travel time between stores and the closest competitor. Given that time is centered at the mean, Philadelphia x 2017 is estimated at the mean travel time to the closest competitor outside of Philadelphia for Philadelphia stores in the sample, which is 12.046 minutes for all stores. Standard errors, which are robust to clustering at the store level, are in parentheses. The sample sizes are store-beverage combinations. Additional variables that are included, but not shown, are a binary variable indicating that the store is located in Philadelphia, a binary variable indicating

that availability is measured after implementation of the tax, store type indicators, and product fixed effects.

Appendix Table 7: Variation in Estimates on Product Availability by Local Population Characteristics

	Percentage of Households in Poverty	Percentage of Population African-American	Percentage of Population Hispanic
All Taxed Beverages			
Philadelphia x 2017	-0.049	-0.042	-0.051
	(0.028)	(0.025)	(0.028)
Phil. x 2017 x Population Characteristic	-0.001	0.001	-0.002
	(0.002)	(0.001)	(0.002)
Observations	10,488	10,488	10,488
Regular Soda			
Philadelphia x 2017	-0.046	-0.058	-0.061
	(0.044)	(0.038)	(0.043)
Phil. x 2017 x Population Characteristic	0.000	0.002	-0.002
	(0.003)	(0.002)	(0.002)
Observations	3,312	3,312	3,312
Diet Soda			
Philadelphia x 2017	-0.056	-0.069	-0.069
	(0.051)	(0.038)	(0.039)
Phil. x 2017 x Population Characteristic	0.003	0.003	0.000
	(0.003)	(0.002)	(0.002)
Observations	2,208	2,208	2,208
All Untaxed Beverages			
Philadelphia x 2017	0.031	0.051	0.041
	(0.046)	(0.030)	(0.043)
Phil. x 2017 x Population Characteristic	-0.002	0.000	-0.001
	(0.003)	(0.002)	(0.002)
Observations	2,208	2,208	2,208
Bottled Water			
Philadelphia x 2017	0.115	0.118	0.112
	(0.065)	(0.041)	(0.068)
Phil. x 2017 x Population Characteristic	0.002	0.002	0.001
	(0.005)	(0.002)	(0.004)
Observations	1,104	1,104	1,104

Notes: The triple interaction represents the change in the DiD estimate for an increase of 1 percentage point in the local population characteristic. Given that each local population characteristic is centered at the mean, Philadelphia x 2017 is estimated at the mean value among stores in the sample. The mean percentage of households in poverty is 27.2 percent. The mean percentage for African-American population is 40.0 percent. The mean percentage for Hispanic population is 23.2 percent. Standard errors, which are robust to clustering at the store level, are in parentheses. The sample sizes are store-beverage combinations. Additional variables that are included, but not shown, are a binary variable indicating that the store is located in Philadelphia, a binary variable indicating that availability is measured after implementation of the tax, store type indicators, and product fixed effects.