Measuring Consumer Responses to a Bottled Water Tax Policy

Peter Berck, Jacob Moe-Lange, Andrew Stevens, and Sofia Villas-Boas

Using panel data of retail purchases, we measure the effects of the introduction, and later removal, of a bottled-water tax in the state of Washington. We use a difference-in-differences approach to measure effects of the tax against untreated stores (in comparable control states) and untreated weeks (the pre-period). We further estimate triple-difference specifications comparing bottled water to juice and milk substitute products. Our results show that, when imposed, the tax causes bottled water sales to drop by nearly 6% in our preferred specification. Sales never fully recover, even after the tax removal. In terms of the heterogeneity of this effect, we find larger quantity drops in high tax rate areas and in the lowest and highest quintile income areas.

Key words: Taxes, difference-in-differences, plastic bottles.

JEL codes: C23, D12, H20, H23, Q53.

In early 2010, Washington Governor Christine Gregoire proposed taxing bottled water, both because of a need for tax revenue and because "… products that negatively impact our environment or public health should be taxed to pay the costs of their effects," (Gregoire 2010). Other West Coast states control polyethylene terephthalate (PET) bottle litter with a deposit and refund system: both California and Oregon have a 5-cent deposit on bottled water, resulting in a 2012 recycling rate of 70% of eligible PET bottles in California.[1,2] Washington's tax on water bottles, which turned out to be short-lived, was intended to reduce the total number of water bottles sold, and hence its negative environmental impact. This paper examines the effect of this disposable water bottle tax on disposable water bottle sales.

Water bottles, mostly lightweight PET bottles, have negative environmental effects. Because of their light weight, they are prone to blow in the wind and pollute both land and sea. These bottles are persistent in the environment and cause problems for domestic and wild animals. When bottles reach the ocean, they become part of a large collection of plastic, which is deleterious to marine life (Barnes et al 2009). Groups opposed to the use of plastic water bottles also cite the use of petroleum in their manufacture and the municipal waste load (Gleick, 2010). On these grounds, there is an economic argument supporting some measures to limit their production and control their disposal. Some critics of bottled water also believe that the continuing trend of bottled water consumption will eventually result in a monopoly in water.[3] While the last concern may have considerable

Peter Berck and Sofia Villas-Boas are professors, and Andrew Stevens is a PhD Candidate at the Department of Agricultural and Resource Economics, University of California, Berkeley. Jacob Moe-Lange is a graduate student in Biology at Stanford University. The authors thank the retailer for sharing these data, and also thank the editor Brian Roe and two anonymous referees for their helpful suggestions, as well as seminar participants at U.C. Berkeley for comments. We are also grateful to the Giannini Foundation for financial support. Correspondence may be sent to: sberto@berkeley.edu.

[1] These rates apply in California for containers under 24 oz. Larger containers have a 10¢ deposit, see Beverage Container Recycling (California Department of Resources Recycling and Recovery 2013) and for all containers in Oregon (Oregon Liquor Control Commission 2013).

[2] California is unique among the "bottle bill" states in having a single-state recycling fund and therefore can accurately compute recycling rates by plastic type. See the Biannual Report of Beverage Container Sales (California Department of Resources Recycling and Recovery 2013).

[3] Former Nestle CEO Peter Brabeck gave an interview in which he discussed clean water as just another commodity versus a fundamental human right. This interview was picked up and amplified by many bloggers and journalists, for instance, Christensen (2013).

Amer. J. Agr. Econ. 98(4): 981–996; doi: 10.1093/ajae/aaw037
Published online May 16, 2016

political legs, imperfect competition in the bottled water market does not seem to be a pressing economic problem.[4]

The use of market-based initiatives to control externalities has been understood since Pigou. In the United States, one of the first market-based initiatives was the (Oregon Liquor Control Commission, 2013), which was a deposit and return program. The Washington bottle tax, while also aimed at reducing environmental externalities, was not as well-targeted toward litter as are deposit return programs. The key economic parameter for tax policies to reduce external effects is the price elasticity of abatement. For the bottle tax studied in this article, the price elasticity of demand determines the level of abatement. A low price elasticity makes programs either environmentally ineffective or expensive. Therefore, knowing the tax elasticity of water bottle demand is the key to knowing how well a bottle tax will abate bottle litter. The other side of the coin is that a tax on a low elasticity good leads to high revenue, which was also one of the aims of the Washington tax.

Using a rich panel dataset of retail consumer purchases from one national retailer from 2007 to 2012, we measure the effects of a recent tax policy change on bottled water, where a tax was first introduced (referred to as the treatment) and later removed in Washington State. We compare these "treatment" stores to "control" stores in Oregon and Idaho. Stores in Oregon and Idaho are similar to those in Washington based on pretreatment observable store characteristics, sales, promotion sensitivity, and consumer demand characteristics. This allows for the use of a difference-in-differences approach to test whether consumers respond to the tax changes, and whether the changes are similar for a tax increase and a tax decrease. The tax rate imposed was different in various Washington localities and we expand our difference-in-differences analysis to account for the heterogeneity in tax rates. We also examine how the tax rate response is sensitive to the income of consumers who live near the stores in our sample.

We perform the same difference-in-differences estimation for two other liquid products (control categories) that did not experience a tax change: juice and non-dairy milk substitutes. Like water, juice is often packed in plastic bottles, while non-dairy milk substitutes are largely sold in other types of containers.[5] We note that since the campaign for the tax initiative mentioned the environmental problems of plastic, it is possible that juice in plastic bottles was also affected by the tax. All three product categories are sold at all stores, meaning they share the same handling costs and changes in shoppers' income. This makes our control categories reasonably, but not perfectly, comparable to bottled water.

In addition to the approaches above, we formally test the difference between the difference-in-differences estimates for juice and milk substitutes and the difference-in-differences estimate for water (a triple difference). The triple-difference estimator is preferred to the difference-in-differences approach when accounting for things like shoppers' income changes or store-specific cost changes that would be different in Washington and the control states. For instance, if Washington stores experienced general cost increases at about the same time as the tax imposition and control state stores experienced no such cost increases, then the difference-in-differences estimator would attribute the effects of the cost increases to the tax imposition while the triple-difference estimator would not make this false attribution. The drawback to the triple-difference estimator is that juice and milk substitutes are also potentially affected by the tax, though in the opposite direction from water, through the cross-price elasticity of demand. Where food cross-price elasticities have been measured in the literature, they are much smaller than the main effect (e.g., Okrent and Alston 2011). Consequently, we expect to see a weakly positive change in the quantities purchased for milk substitutes and juice through this cross-price elasticity effect. Our triple-difference specifications therefore provide a bound on the tax effect.

Sales taxes and shipping costs (for online purchases) are not explicitly shown in the displayed price of an item, but are instead added at the time of purchase. Such costs are termed non-salient. There is a small but

[4] The Herfindahl index for bottled water is 1,650, well below the threshold in the merger guidelines. The source is a Nestle Waters (2013) 2011 market share chart.

[5] The category contains soy and almond milk substitutes and a very small number of organic milk products.

growing literature that shows that consumers have an attenuated response to non-salient costs. Zheng, McLaughlin, and Kaiser (2013) show that 58% of the shoppers in their sample are misinformed about the taxable status of food and beverages. With a labeling experiment, Chetty, Looney, and Croft (2009) find that the sales of taxable products at a grocery store are reduced when their tax-inclusive price is displayed in addition to the tax-exclusive price. Similarly, Hossain and Morgan (2006) find that eBay customers do not sufficiently take shipping costs into account when placing bids. In the case of Washington's tax on bottled water, a $16.5 million campaign to repeal it made this tax much more salient to consumers than most tax changes, alleviating some of the above concerns and giving us a good indication of the efficacy of a market-based approach to controlling an externality caused by a consumer product.

Among the recent literature studying the impact of sales taxes on consumer demand, the papers most relevant to our study focus on sugar-sweetened beverages. Several papers address the question of whether sales taxes on sugar-sweetened sodas have an impact on either consumers' consumption of these products or consumers' weight (Powell, Chriqui, and Chaloupka 2009; Sturm et al. 2010; Fletcher, Frisvold, and Tefft 2010, 2015). These studies generally find no significant effects, possibly due to the low salience of sales taxes relative to excise taxes While numerous studies estimate how a beverage tax would affect consumer demand (e.g., Zhen et al. 2014), our work is relatively rare in that we exploit both cross-sectional and temporal variation in tax rates rather than merely price variation in order to identify an effect. This makes our findings more reliable and realistic than previous estimates.

Our results are as follows: in the difference-in-differences specification, when taxed, the average quantity of bottled water purchased in Washington drops significantly, by 5.9%, compared to the untaxed control states. Even after the tax is removed, water consumption remains 3.3% lower than the baseline. Using the differences in tax rate by locality, we find suggestive evidence that localities with higher tax rates had larger drops in water consumption. However, the price effects alone do not tell the whole story, as we find that localities with both low and high levels of income experienced larger reductions in quantity than did localities with average levels of income.

Turning to the two control categories, milk substitutes are unaffected by the tax change regime. Juice, however, experiences reduced sales during the taxed months. The difference-in-differences estimator for juice is a 3.1% drop in consumption. If that were because of forces (perhaps income changes unaccounted for in quarter by year fixed effects) common to juice and water, then the drop in water consumption solely due to taxation would be 2.8% instead of 5.9%.

The rest of the article proceeds as follows. The following section describes the tax change and its legislative history. The next section describes the data and examines the comparability of the observed stores in Washington where the tax was imposed, and in Oregon and Idaho where the tax was not imposed. A section on empirical strategy follows, and describes the difference-in-differences estimator, the difference-in-differences estimator with heterogeneity, and the triple-difference estimator using both juice and milk substitutes as comparison categories. The results for all three empirical strategies are in the succeeding section, which is followed by a concluding section.

The Tax Change

Washington, unlike Oregon and California, does not have a bottle deposit program. Washington thrice voted such a program down by initiative, the last time with 70% voting no.[6] On April 12, 2010, the Washington state legislature passed the Second Engrossed Substitute Senate Bill 6143, legislation that, *inter alia*, repealed the sales tax exemptions on candy, soda, and bottled water effective June 10, 2010. The law, RCW 82.08.0293 states that "Until July 1, 2013, the exemption of 'food and food ingredients' . . . does not apply to prepared food, soft drinks, bottled water, candy, or dietary supplements."[7] It was calculated that the law would bring revenue of about $100 million per year, and the bottled water tax was specifically projected to provide $32.6 million in yearly revenues.

---

[6] For a history of the regulation of bottles in Washington, see Virgin (2007).

[7] Exemptions from sales tax for food and similar items are common. In California, bottled water is exempt from taxation. The Washington exemptions are listed in Revised Code of Washington, Title 82 Chapter 8 Section 0293.

As soon as the governor's ink was dry on the bill, the American Beverage Association (ABA) gathered signatures and filed for a referendum on the increased tax, creating Initiative Measure 1107 (Garber 2010). The repeal campaign debated the costs to consumers relative to the benefits of tax revenues for schools, with little focus on environmental issues. Groups in favor of the repeal spent $16,042,629 in campaign money to repeal the measure, almost all coming from the ABA (LaCorte 2010). The campaign against the repeal spent a meager $426,828 (La Corte 2010). Initiative 1107 succeeded with over 60% of the vote on November 2, 2010, restoring the sales tax exempt status of bottled water effective December 2, 2010.[8]

The net result of the law and the initiative on bottled water was that sales tax was charged on bottled water from June 10 to December 1, 2010, inclusive. Because the total sales tax levied differs by city and county, the effect of the repeal of the exemption and the rescission of the repeal differs by locality. There is a statewide sales tax of 6.5% plus local sales taxes. As a result, the *ad valorem* tax rate on bottled water varied across the state from a low of 6.5% to a high of 9.5%.

Empirical Setting and Data

Our data come from one national supermarket chain that has stores in the treated area—Washington—and a neighboring untreated area comprised of Oregon and Idaho. The data are on three categories of products: water, which is the treated product category; juice, which is an untreated product category; and non-dairy milk substitutes, which is also an untreated product category. In this section, we describe the data for these product categories and examine the comparability of the stores in the treated and untreated areas.

Data

From the retailer, we obtained a panel data set of store-level weekly sales at the product-version (UPC) level for three categories: water, juice, and non-dairy milk substitutes. The panel begins January 1, 2007 and ends May 8, 2012, which includes the date of tax imposition, June 1, 2010, and date of tax removal, December 3, 2010. An observation is the total revenue and total quantity sold of a particular UPC in a particular week in a particular store. Revenue is stated as gross, which is before discounts and exclusive of tax, and as net, which is after discounts and also exclusive of tax. The net and gross prices are found by dividing the revenue variables by quantity sold. The regressions below will include store-UPC fixed effects, week of the year fixed effects, and year-quarter fixed effects (for 22 quarters). In addition, these data from the retailer are matched with (1) the weekly average temperature in each store location, as temperature is a determinant of beverage sales that can vary by time and location (and therefore is not duplicative of the store-product or year-quarter fixed effects), (2) the sales tax rate in the treated stores, and (3) the median household income of the ZIP Codes where each store is located.

Stores

The supermarket chain where we perform the empirical analysis is a large national chain, which covers a wide range of demographic areas and competes with similar supermarkets for the sale of grocery products in the United States and in Canada. While using data only for this retailer may not lead to a U.S. representative purchase outlet sample, the advantages of using this retailer as the empirical setting for our experimental design are that the stores in the treated state and the control states are in the same corporate price division and share the following similarities: store layouts; promotional efforts; highlighted products;, and posted prices. Because these stores are in the same price division, the retailer could not have systematically adjusted product prices or promotional efforts differentially across stores inside and outside of the treatment area (Washington). We utilize data for all stores in both the treated and control areas.

We have a long pretreatment period time series of all sales, number of products, and consumer purchases for stores, and thus compare treated and control stores based on pretreatment observable data levels and trends.

Table 1 presents summary statistics for log of quantity, gross price, number of stores, and number of products sold. These statistics are presented for six cases defined as the three

[8] The initiative also restored the tax-exempt status for gum and candy and repealed the 2¢ per 12 oz. tax on soda. (Washington Department of Revenue 2010).

Table 1. Means of Treated and Control Product Categories

		Water		Juice		Milk Substitutes	
Period	Variable	Control Stores	Treated Stores	Control Stores	Treated Stores	Control Stores	Treated Stores
Pre-tax	Log(Q)	2.03	2.16	1.14	1.22	0.91	0.94
		(1.30)	(1.38)	(0.99)	(1.01)	(0.81)	(0.83)
	Gross Price	2.74	2.78	3.61	3.62	2.37	2.39
		(2.05)	(2.10)	(1.38)	(1.33)	(0.73)	(0.73)
	Number of Stores	107	170	107	170	82	104
	Number of UPC IDS	68	74	239	248	21	21
Tax policy	Log(Q)	2.16	2.23	1.14	1.22	0.86	0.87
		(1.30)	(1.39)	(0.97)	(0.99)	(0.80)	(0.81)
	Gross Price	2.33	2.35	3.39	3.39	2.54	2.60
		(1.62)	(1.64)	(1.21)	(1.15)	(0.78)	(0.83)
	Number of Stores	104	166	104	166	77	106
	Number of UPC IDS	63	71	171	216	17	17
Tax removal	Log(Q)	2.00	2.10	1.14	1.22	0.78	0.80
		(1.25)	(1.32)	(0.96)	(0.99)	(0.77)	(0.78)
	Gross Price	2.47	2.48	3.41	3.44	2.64	2.70
		(1.81)	(1.87)	(1.14)	(1.12)	(0.78)	(0.83)
	Number of Stores	103	166	103	166	74	105
	Number of UPC IDS	76	82	198	207	20	20

Source: Author's calculations from scanner data. *Note*: Standard deviations appear in parentheses. The pre-tax period is January 2007 through May 2010, the tax period is June 2010 through November 2010, and the post-tax period is December 2010 through May 2012.

product categories and the treated and control states. Each of these cases is examined in three time periods: pre-period, tax period, and tax removal period.

Treatment Effect without Controls

Table 1 shows changes in average quantity that are contemporaneous with the tax policies while firm-level strategic variables, such as price, remain essentially unchanged across the treatment and control groups. Looking at the main determinant of quantity sold—the price—we can see that the average price, by product category, is basically the same in the pre-tax period for control and treated stores. Where it does change from period to period, price changes similarly for the treated stores and control stores.[9] Therefore, the tax change creates a higher tax-inclusive price in the treated than in the control stores. An estimate of the treatment effect that does not include controls for time and place is the difference in the quantity change between the treated and untreated stores in response to this tax increase.

Since the quantity is in log format, differencing across periods for each column of table 1 gives us the percentage change in quantity coincident with the tax changes. We observe a 6% negative difference in means between treated and untreated stores due to the tax introduction, and a 3% negative difference in means in the tax removal period. Taken together, these two differences-in-means point to an incomplete rebounding of consumption in the treated stores when the tax was removed compared to the control stores. For the juice and milk substitute categories, quantity sold and prices are roughly unchanged during the tax introduction and subsequent policy removal. Beyond these difference-in-means comparisons, table 1 highlights the need to use at least a difference-in-differences approach: contemporaneous with the tax imposition on the treatment group, there are changes in the prices and quantities of water in the control group. Thus, a formal difference strategy is called for.

Similarity of Treated and Untreated Stores

A formal difference strategy requires that the control and treatment groups be similar in

[9] The average price reported is over all products actually sold. The average water price in pre-period in the control stores is 2.74, while it is 2.78 in the treated stores. A slightly different mix of UPC codes actually sold in control and treated stores accounts for this difference.

Table 2. Treated and Control Stores in the "Pre" Period for Water

	Water		
Variables	Control Stores	Treated Stores	P-value of Difference
Average (log (Q))	2.03 (0.0014)	2.16 (0.0011)	0.000
Average Gross Price	2.74 (0.0022)	2.78 (0.0017)	0.000
Median Income ($)	40698.39 (9728.65)	46722.76 (12258.94)	0.000
Building Size (sq ft)	44439.77 (12058.77)	46713.71 (11865.69)	0.1256
Selling Area (sq ft)	30811.67 (8973.73)	31950.93 (8509.37)	0.2952

Source: Author's calculations from the scanner data. Standard deviations appear in parentheses. Income from the 2000 Census Data.

the pretreatment period. The question is whether the pre-period is balanced in terms of observable determinants of water demand and pre-existing trends or whether there are some observable determinants of demand that do not match between treatment and control stores. As the match becomes less exact, it becomes more important to take advantage of the panel structure of our data. The panel allows us to control for (1) differences between treated stores in the treated state and control stores in the other states, (2) differences between the treated category (water) and the untreated categories (juice and milk substitutes) within treated stores, and (3) differences in season or year. These controls are implemented with (1) product-store fixed effects that will control for observed and unobserved time-invariant differences in determinants of demand at the product-store level, and (2) the inclusion of year-quarter and week of the year fixed effects that are common to all products.

Table 2 presents summary statistics for the treated stores and control stores for the water category using data only for the pre-policy period, that is, until June 1, 2010. While treated stores have statistically higher quantities sold and higher median incomes, on average, compared to control stores, the sample averages for quantity sold are particularly qualitatively similar, suggesting that the treatment and control stores share broadly similar patterns in the pre-period. We also conclude that there is no significant difference in building size or selling area between treatment and control stores.

In terms of the pre-period trends in the quantity sold, obtained by regressing quantity on a time trend for the treatment and control stores separately, the point estimates of the trend in treatment and control stores are not statistically different from each other. Looking at figure 1, which shows water quantity sold by week during the pre-period (before June 1, 2010) and during the tax introduction period, we see there are no important differences in trends in Washington compared to the control states. To the extent that these differences are constant over time, store fixed effects will control for all possible time-invariant determinants of water demand, such as the possible observable differences identified in table 2. We now turn to describing the estimating equations.

Empirical Strategy

Our empirical strategy to estimate the average effect of the tax change on quantity of bottled water sold is to consider stores in the tax-changing state (Washington) as treated stores and stores in the neighboring states (Oregon and Idaho) as control stores. We further control for temperature, which is a determinant of water demand that changes locally (at less than the level of a state), control for prices, and use time and product-store fixed effects in our econometric specifications.

In the previous section we established that control and treated stores are very similar in the pre-period, and that it is reasonable to use the Oregon and Idaho stores as a control group. The remaining assumption (the Stable Unit Treatment Value assumption) needed for a difference-in-differences approach is that the treatment (tax) applied to one unit does not affect the outcome of other units,

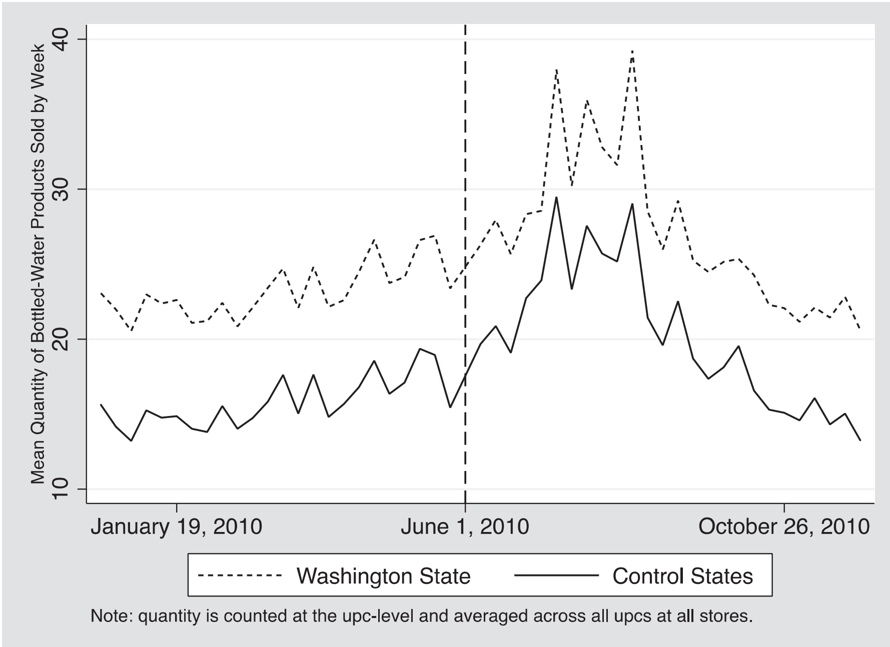

Figure 1. Average quantity of water sold by week and state

and that the effect of a given level of treatment (tax rate) is the same for every unit taxed at that rate (Imbens and Rubin 2015).[10] In our case, we estimate a model that assumes every taxed unit is equally affected, as well as a model where units receive different levels of treatment because they have slightly different tax rates. Since we observe the removal of Washington's tax as well as its imposition, there are two treatments in our model (imposition and removal), and we find the effect of each of these events on quantity sold. These are our first two specifications: the difference-in-differences and the heterogeneity of treatment. Subsequently, we estimate a triple difference, using juice and milk substitutes as control categories. We now discuss these estimators in turn.

Difference-in-differences Empirical Specifications

We utilize a difference-in-differences approach to find the effect of the tax changes on the quantity of bottled water sold. In these regressions, the products are distinguished by bar code (UPC) and the outcome of interest is the log of the product's quantity sold. The data are collected by week and by store for each product. Thus, Q_{isw} is the quantity of product i in store s in week w. There are stores in Washington, the treatment stores, where the tax was imposed and removed, and in the neighboring states of Oregon and Idaho, where there was no tax change. The dummy variable T_{is} equals one only for products in a treated store. Two-time dummy variables, r_{iw} and t_{iw}, define three time periods: the weeks before the tax was introduced, where both t_{iw} and r_{iw} are zero, the weeks during the collection of tax, when t_{iw} is nonzero, and the time after the tax was removed, when r_{iw} is nonzero. We call these periods "pre," "during," and "removal."

We estimate several distinct difference-in-differences specifications, each including a different set of controls. This allows us to assess the extent to which our estimate of the treatment effect is sensitive to different underlying assumptions. Our preferred specification includes product-store fixed effects, time fixed effects, and net price.

Our least restrictive specification only includes data on water products and average weekly temperature in degrees Celsius (C). Although useful for examining the average treatment effect of the tax change on the

[10] See Ravallion et al. (2005), Imbens and Wooldridge (2009), and Flores-Lagunes and Timko (2014), who provide an excellent and historical development of difference-in-differences type estimators.

treated water categories, this specification does not control for potentially important covariates that, if omitted, could lead to a biased estimate of the treatment effect. For example, there exist many different types of water products and consumer demand between stores may differ across products. To reduce the likelihood that the estimated treatment effects are biased, in our next specification we include dummy variables for products interacted with individual store dummies, as well as the weekly price. In our final and preferred specification, we add week fixed effects to control for seasonal-weekly level changes that are common across all stores and regions, as well as year-by-quarter fixed effects. This specification is given by:

$$(1)\quad \ln Q_{isw} = \alpha_{y-q} + \alpha_w + \alpha_{is} + \beta_0 + \beta_2 t_{iw} + \beta_3 T_{is} t_{iw} + \beta_4 r_{iw} + \beta_5 T_{is} r_{iw} + \beta_6 C_{isw} + \beta_7 p_{iw} + \varepsilon_{isw},$$

where the coefficients on t_{iw} and r_{iw} are time period effects common to the control and treatment stores, the coefficient for T_{is} t_{iw} is the true effect of the treatment, and the coefficient on T_{is} r_{iw} is the true effect of the removal of treatment. Product-store fixed effects are denoted by $\alpha_{is,}$ price is denoted by p_{iw}, week-of-year fixed effects are denoted by α_w, and year-by-quarter fixed effects are denoted by $\alpha_{y\text{-}q}$.

Empirical Specifications Considering Heterogeneity

In addition to the specifications above, we estimate specifications in which we allow the treatment to have a different effect on each tax region, as the tax changes differed by regions, and also allow the treatment to have varying effects according to the demographics in stores' locations.

Because different localities in Washington have different levels of local sales taxes, tax rates vary across stores. Table 3 shows that, other than the two stores with a tax rate of 6.5%, the stores in our sample were exposed to a sales tax rate of between 8% and 9.5%. These differential levels of taxes will allow us not only to estimate the average treatment effect of a tax change, but also effect heterogeneity with respect to the tax level.

We explore this heterogeneity in tax level and income by modifying specification (1) for the difference-in-differences and allowing the coefficients of interest to vary according to the tax level or by the income level in the area in which the store is located. For tax level, instead of using one dummy variable for the weeks that the tax was imposed (respectively, removed), we use a set of dummy variables, one for each tax rate range, interacted with the dummy for the weeks the tax was imposed (respectively, removed). This means that all stores that were in localities with a tax rate of 9.5% would share the same dummy variable for tax rate imposed and similarly for the other tax rates. This gives one treatment effect for the imposition and removal of each tax rate range. In the supplementary appendix available online, we also estimate specifications where a region's tax rate is interacted with our treatment dummy to create a linear estimate of how the tax rate affects our results.

Table 3. Tax Ranges and Number of Stores in Each Tax Range

Tax Range	Number of Stores with specified Tax Range
6.50%	2
7.00%	0
7.50%	0
8.00%	16
8.50%	45
9.00%	29
9.50%	78
More	0

Source: Local Sales and Use Tax Rates. Washington State Department of Revenue, 2010. *Note*: These are tax range floors, so the first bin is [0.065, 0.07).

In addition to tax rates, we explore heterogeneity across the demographics in store locations. Using census data from 2000, we determine the median household income of the ZIP Codes where each store is located. We then repeat the same steps as with tax rates to explore whether demand responses are different in locations with different levels of median household income.

Triple-difference Empirical Specifications

In a triple-difference specification, we include products in a comparable category as an additional counterfactual, as well as including all the variables in equation (1). Conceptually, the triple difference for juice (or milk substitutes) is realized by evaluating the difference-in-differences for water, DD(water), and for juice, DD(juice), and forming DDD = DD(water) – DD(juice).

Specification (2) of the triple difference, with the parameter of interest of β_7 for the tax policy, and the parameter β_{12} for the tax removal, is given by

$$(2)\quad \ln Q_{isw} = \alpha_{y-q} + \alpha_w + \alpha_{is} + \beta_0 + \beta_2 t_{iw} + \beta_3 O_i + \beta_4 T_{is} t_{iw} + \beta_5 O_i * T_{is} + \beta_6 O_i * t_{iw} + \beta_7 O_i * t_{iw} * T_{is} + \beta_8 p_{iw} + \beta_9 r_{iw} + \beta_{10} T_{is} r_{iw} + \beta_{11} O_i * r_{iw} + \beta_{12} O_i * r_{iw} * T_{is} + \beta_{13} Cisw + \varepsilon_{isw},$$

where O_i is a dummy signifying that a product is a bottled water product. Our triple-difference specification allows us to control for any unobserved changes in demand that vary across stores and time in a way similar to Washington's tax on bottled water.

Results

We first present the average change in the quantity of bottled water purchased in response to tax and tax-removal, based on the difference-in-differences identification strategy. Next, we explore the heterogeneity of this effect across different tax levels and income groups. Finally, we compare the change in the quantity of bottled water purchased to the change in the quantity of bottled juice and non-dairy milk substitutes purchased, using the triple-difference identification strategy.

Average Effects of the Tax Policy and later Tax Removal

Results for the difference-in-differences specifications are presented in table 4, which is organized as follows. The log of quantity sold is the dependent variable in all regressions. Column (1) reports the results from our least restrictive specification where the independent variables are a constant, the temperature, the tax introduced time dummy ("Tax Introduced"), the tax removed time dummy ("Tax Removed"), the treatment store indicator ("WA"), and the interaction of the two time dummies and the treatment store dummy ("Tax Introduced*WA and Tax Removed*WA"). These interaction terms correspond to the tax policy average treatment effect point estimate. Column (2) performs the same regression but adds

Table 4. Difference-in-differences Regression for Log of Quantity of Water

VARIABLES	(1)	(2)	(3)	(4)	(5)
Tax Intro * WA	−0.0576***	−0.0397***	−0.0388***	−0.0409***	−0.0589***
	(0.0111)	(0.00747)	(0.00745)	(0.00740)	(0.00728)
Tax Removed * WA	−0.0318***	−0.0240***	−0.0233***	−0.0228***	−0.0329***
	(0.0114)	(0.00764)	(0.00761)	(0.00763)	(0.00766)
Temperature	0.0183***	0.0209***	0.0156***	0.0156***	0.0164***
	(0.000270)	(0.000161)	(0.000309)	(0.000309)	(0.000303)
Tax Introduced	0.0511***	−0.0103*	0.0282***	0.0304***	0.0170***
	(0.00881)	(0.00589)	(0.00605)	(0.00602)	(0.00588)
Tax Removed	−0.00922	−0.0149**	−0.0123	−0.0105	−0.0425***
	(0.00910)	(0.00602)	(0.00757)	(0.00756)	(0.00736)
WA	0.140***				
	(0.0179)				
Gross Price				−0.0532***	
				(0.00456)	
Net Price					−0.520***
					(0.00472)
Constant	1.839***	1.905***	2.055***	2.202***	3.350***
	(0.0136)	(0.00210)	(0.00654)	(0.0131)	(0.0131)
Product-Store FE	No	Yes	Yes	Yes	Yes
Time FE	No	No	Yes	Yes	Yes
Observations	3,949,346	3,949,346	3,949,346	3,949,346	3,949,346
R-squared	0.009	0.033	0.042	0.042	0.119
Number of upc_store		31,049	31,049	31,049	31,049

Note: Standard errors appear in parentheses, clustered at the product-store level. Asterisks indicate the following: ***$p<0.01$, **$p<0.05$, and *$p<0.1$. Time fixed effects include weekly dummies and quarter by year dummies.

product-by-store fixed effects. Column (3) adds seasonal and time fixed effects to the specification in the previous column by adding weekly dummies and year-by-quarter dummies. Column (4) adds shelf gross price ("Gross Price") to the specification in Column (3), and finally in column (5) we report the estimates for the same specification as in column (4) except that we use net shelf price ("Net Price") rather than gross price. Because net price represents the average price actually paid by consumers (after promotions), it is a better indicator of "effective" price, and thus more valuable for our analysis than gross price. Standard errors for all specifications are robust to heteroskedasticity and clustered at the level of the fixed effects, that is, product-store.

The addition of fixed effects and controls for price make a difference in the regression coefficients. From table 4, we see that on average consumers purchased 14% more quantity per product of water in Washington than in the control states, as shown by the first column estimates in the row "WA." In the remaining columns this place fixed effect is subsumed in the store by products fixed effects (and therefore not estimated). When comparing column (3) with product-store, time, and seasonal controls to column (5) that additionally controls for net price, we see that the positive effect of being in the tax period falls substantially. For the tax removal row, again comparing columns (3) and (5), we see that the removal weeks had substantially lower quantity than the pre-period week once we account for net price. The effect of temperature is significant in all of the specifications: when controlling for everything else, each additional degree Celsius results in a 1.6% increase in water sales.

Looking now beyond the first differences of the previous paragraph, we start with a pure difference-in-differences without fixed effects in column (1). We estimate a statistically significant 5.8% drop in quantity of bottled water products sold due to the tax introduction, given by the coefficient associated with the interaction in row "Tax Intro * WA." We further estimate a 3.2% drop when the tax was removed, as compared to the baseline pretax period, given by the coefficient in the row titled "Tax Removed * WA." When we control in column (2) for fixed effects at the product store level, in column (3) for weekly seasonal effects, and then in column (4) for shelf prices, we find significant effects of the tax introduction and tax removal that are smaller in magnitude than the pure OLS specification in column (1). In column (5), controlling for price net of discounts, we find a larger significant drop of 5.9% for the tax introduction period relative to the baseline pre-period quantity, as well as a significant drop of 3.3% for the tax removal policy period relative to the baseline pre-period average quantity. The primary findings from table 4 are as follows: the average treatment effect for the tax introduction is a decrease in the range of 3.9 to 5.9%; the average treatment effect for the tax removal shows that the quantity never fully rebounded, as it dropped relative to baseline by about 2.3 to 3.3%. However, prices appear to have played an important role in explaining these changes. Given the difference in the treatment effect between specifications (3), (4), and (5), it is possible that not only did the quantity of bottled water products sold drop, but consumers may have switched to products with lower prices.

To look at what happened to prices of bottled water products purchased during the policy changes, we turn to table 5. The dependent variable in column (1) is the log of gross shelf price, while the dependent variable in column (2) is the log of price net of discounts. In both specifications, the right-hand side variables are the same as in the specification of column (3) of table 4,

Table 5. Gross and Net Price Regressions

VARIABLES	(1) Log Gross Price	(2) Log Net Price
Tax Intro *WA	−0.0189***	−0.0262***
	(0.00555)	(0.00376)
Tax Removed *WA	0.00168	−0.0105***
	(0.00523)	(0.00351)
Temperature	−0.000166***	0.000586***
	(0.0000387)	(0.0000541)
Tax Introduced	0.0273***	0.0199***
	(0.00360)	(0.00267)
Tax Removed	0.0291***	0.00222
	(0.00339)	(0.00299)
Constant	0.772***	0.679***
	(0.00180)	(0.00248)
Product-Store FE	Yes	Yes
Time FE	Yes	Yes
Observations	954,802	954,802
R-squared	0.264	0.091
Number of Products-Store	3,415	3,415

Note: Standard errors appear in parentheses, clustered at the product-store level. Asterisks indicate the following: ***$p < 0.01$, **$p < 0.05$, and *$p < 0.1$.

controlling for temperature, product-store level price determinants, weekly seasonal price determinants, and quarter by year price determinants. In this table, we restrict our analysis to the 3,415 product-store goods that were sold in at least 98% of the weeks in our sample. In other words, this table enforces a particularly strong panel of products to reduce the statistical noise of products being introduced and removed throughout the study period.

We can see how prices throughout the retailer's pricing division changed during and after the bottled water tax by investigating the "Tax Introduced" and "Tax Removed" rows in table 5. During the period when taxes were introduced, the prices consumers paid in all stores in both treated and control states increased 2.7% for gross and 2.0% for net prices after controlling for time fixed effects. This can be seen in the row "Tax Introduced." During the "Tax Removed" period, gross prices increased by 2.9% while the net prices that consumers paid were not statistically different from those in the pretax period.

We find that both the gross and net prices that consumers paid changed differentially across Washington and the control states when the tax was introduced. This can be seen by the statistically significant 1.9% drop in gross prices of products that consumers purchased and the 2.6% drop in net prices that consumers purchased, shown in the row titled "Tax Intro *WA." Looking now at the coefficient associated with "Tax Removed * WA," we find that gross consumer prices of products consumers purchased did not change differentially when the tax was removed in the treated states relative to the control states. However, interestingly, consumers made continued use of promotions: the net price of products that consumers purchased in the treated states changed differentially by a 1% drop relative to the control states when the tax was removed.

Taken together, table 5 shows that any differential changes in the price of bottled water products across treatment and control stores during the tax period were no larger than 3%. These price changes are notably smaller than the 6.5% to 9.5% tax in Washington. By presenting specifications in table 4 without any prices (columns (1)–(3)), with gross prices (column (4)), and with net prices (column (5)), we are able to demonstrate the relative stability of our estimated quantity response across different theoretical assumptions. Our preferred specification controls for net price and concludes that bottled water sales dropped significantly due to the tax introduction, by about 6%, and never rebounded to pretax levels.

Investigating Heterogeneity

We now turn to investigating the differential effects that depend on the level of the tax rate or the income level of the ZIP Code of the treated stores. For a more thorough treatment of these specifications, including full regression tables, we refer readers to the supplementary appendix available online.

We begin with heterogeneity in the change in taxes. Because different parts of Washington faced different sales tax rates, there is heterogeneity in treatment as described in table 3. Table 6 presents our estimates of how bottled water sales changed during and after the Washington tax across different tax rates. Areas with higher tax rates (specifically tax rates in the two highest brackets) have the largest and most statistically significant reduction in bottled water sales when the water tax is imposed. A similar pattern emerges when looking at the tax removal point estimates: areas with the highest tax rates also remained significantly below baseline consumption after the tax was removed. Taken together, the evidence presented in table 6 is consistent with the tax introduction acting like an after-tax price increase. The larger the price increase due to the higher tax rate, the larger the quantity drop. We note that the implied elasticities are always below one in absolute value, hinting that water demand is inelastic, as, for example, a tax increase of 9.5% results in a 6.6% drop in quantity sold.

Table 6. Heterogeneous Effects by Tax Rate

Tax Rate	Change in bottled water sales in WA during tax	Change in bottled water sales in WA after tax removal
6.5%	−4.8%	2.7%
8.0%	1.1%	−0.9%
8.5%	−1.2%	−2.8%**
9.0%	−7.3%***	−6.6%***
9.5%	−6.6%***	−3.7%***

Note: For full regression results, see table A.1 in the supplementary appendix online. Asterisks indicate the following: ***$p < 0.01$, **$p < 0.05$, and *$p < 0.1$.

In table 7, we present results allowing for heterogeneity with respect to the income of the area where the stores are located. For each store, we determine the median household income of the surrounding ZIP Code. We next create dummy variables for whether that median income is in the first, second, third, fourth, or fifth quintile of national household incomes (Q.1, Q.2, etc.). We then interact those indicators with the treatment effect of both tax introduction and tax removal.

We find that the effect of the bottled water tax is largest for the second and fourth income quintiles and generally smallest for the third income quintile. This suggests a slight inverted-U shape in quantity response by income level. However, we are wary to lean too heavily upon these results since none of our observations come from first-quintile areas, and less than 1% of our observations come from fifth-quintile areas. Looking now at the tax removal point estimates, we find that bottled water consumption in the fourth income quintile remains much lower below baseline than other income quintiles, even after removal of the tax. Our findings suggest that for medium-high (fourth quintile) income quintile areas, bottled water sales not only drop with the tax, but never rebound and rather stay significantly below pre-tax baseline levels. Furthermore, if we weight our results across income quintiles, we find an estimated 5.8% net reduction in bottled water sales for Washington as a whole, which is qualitatively similar to the finding in our preferred specification in column (5) of table 4.

Evidence from the Triple-difference Approach

Unobserved events outside of our study, such as the opening of competitive stores in Washington and not the control states, would cause a decrease in sales of non-treated products in only the treated state stores. The triple-difference approach removes these time-by-place effects that are largely common to water, milk substitutes, and juice. Given this possibility, the triple-difference specification is a more conservative measure of the effect of the tax introduction on water quantity sold.

In a triple-difference specification, we include products in a comparable category as an additional counterfactual, as well as including all the variables in equation (1). We estimate equation (2) of the triple difference, with the parameter of interest of β_7 for the tax policy, and the parameter β_{12} for the tax removal, for the juice and for the milk substitute category separately. Table 8 presents results for specifications that include product-store fixed effects, time fixed effects, and net prices, as in column (5) of table 4 (results from specifications omitting price or using gross price are qualitatively similar and available upon request from the authors).

Looking now at the results estimated using the triple-difference identification strategy of equation (4), we turn to column (1) of table 8 for juice, and column (3) of table 8 for milk substitute category comparisons to water. The triple-difference coefficient of interest for the tax introduction effect on quantity sold is obtained by computing the difference in the point estimate for the water difference-in-differences row "Water*Tax Intro* WA", minus the point estimate of the comparable category difference-in-differences, "Juice*Tax Intro*WA" and "Milk*Tax Intro* WA," respectively, in columns (1) and (3) of table 8. Similarly, subtracting "Juice*Tax Removed* WA" ("Milk*Tax Removed * WA") from "Water* Tax Removed* WA," we obtain the triple-difference estimate of the effect on quantity sold when the tax was removed relative to the baseline pre-period. These differences and their p-values are reported in the

Table 7. Heterogeneous Effects by Household Income

Median household income in a store's ZIP Code (quintiles of national household incomes)	Change in bottled water sales in WA during tax	Change in bottled water sales in WA after tax removal
Quintile 2	−7.1%***	−2.2%
Quintile 3	−3.5%***	−2.1%**
Quintile 4	−6.5%***	−9.0%***
Quintile 5	−4.8%	−2.6%

Note: For full regression results, see table A.2 in the supplementary appendix online. Quintile 1 is omitted since no stores are located in a ZIP Code where the median household income falls in the first quintile of national household income. Asterisks indicate the following: ***$p < 0.01$, **$p < 0.05$, and *$p < 0.1$.

rows "Triple Difference*Tax Intro" and "Triple Difference*Tax Removed."

We additionally include a specification (column (2)) where we perform the triple difference with juice but restrict our sample to use only those observations from stores included in our triple difference with milk substitutes. This restriction allows us to more directly and accurately compare how our triple-difference estimates differ depending on which of the two comparison product categories we use.

Table 8. Triple Difference: Water Relative to Juice and Milk-substitute Sales on Tax Introduction and Removal

VARIABLES	(1) Log quantity Juice and Water	(2) Log quantity Juice and Water, restricted sample	(3) Log quantity Milk Subs. and Water
Triple Difference Tax Intro	−0.0277***	−0.0362***	−0.0487***
p-value	0.00	0.00	0.00
Triple Difference Tax Removal	0.0013	−0.0117	−0.0490***
p-value	0.87	0.22	0.00
Water*Tax Intro*WA	−0.0589***	−0.0693***	−0.0582***
	(0.00729)	(0.00860)	(0.00728)
Water*Tax Removed*WA	−0.0329***	−0.0455***	−0.0327***
	(0.00768)	(0.00899)	(0.00765)
Juice*Tax Intro*WA	−0.0312***	−0.0329***	
	(0.00242)	(0.00287)	
Juice*Tax Removed*WA	−0.0342***	−0.0338***	
	(0.00282)	(0.00332)	
Milk*Tax Intro*WA			−0.00949
			(0.00971)
Milk*Tax Removed*WA			0.0163
			(0.0109)
Temp*Water	0.0236***	0.0242***	0.0169***
	(0.000180)	(0.000219)	(0.000268)
Temp*Juice	−0.0210***	−0.0214***	
	(0.000165)	(0.000200)	
Temp*Milk			−0.0188***
			(0.000210)
Juice*Tax Introduced	−0.00461**	−0.00183	
	(0.00218)	(0.00253)	
Juice*Tax Removed	−0.0411***	−0.0389***	
	(0.00292)	(0.00341)	
Milk*Tax Introduced			−0.00947
			(0.00834)
Milk*Tax Removed			−0.0816***
			(0.00989)
Water*Tax Introduced	0.0524***	0.0613***	0.0158***
	(0.00569)	(0.00655)	(0.00575)
Water*Tax Removed	0.0791***	0.0897***	−0.0249***
	(0.00619)	(0.00709)	(0.00702)
Net Price	−0.521***	−0.517***	−0.492***
	(0.00128)	(0.00153)	(0.00357)
Constant	3.074***	3.037***	3.064***
	(0.00435)	(0.00518)	(0.00988)
Product-Store FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Observations	22,626,082	15,810,776	4,809,547
R-squared	0.147	0.146	0.111
Number of upc_store	251,560	177,441	45,184

Note: Standard errors appear in parentheses, clustered at the product-store level. Asterisks indicate the following: ***$p < 0.01$, **$p < 0.05$, and *$p < 0.1$. Specification (2) uses data only from stores included in specification (3).

Table 9. Summary of Treatment Effect Size across Specifications

SPECIFICATION	Change in bottled water sales in WA during tax	Change in bottled water sales in WA after tax removal
Difference-in-differences	−5.9%***	−3.3%***
Triple difference, juice	−2.8%***	0.1%
Triple difference, juice (restricted sample)	−3.6%***	−1.2%
Triple difference, milk substitutes	−4.9%***	−4.9%***

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$ *Note*: In the restricted sample we use only juice observations from stores included in our triple difference with milk substitutes.

Beginning with column (1) of table 8, we see that when the tax on bottled water was introduced, water sales increased significantly everywhere over the base period in both the tax introduced and tax removed period. (See the rows "Water* Tax Introduced" and "Water* Tax Removed.") However, juice sales drop by 0.5% during the tax introduction and 4.1% during the tax removal. In theory, the tax changes for bottled water could cause spillover effects to other bottled products in the same store. In this case, theory would predict that consumers would be more likely to switch to bottled juice in Washington, relative to control states, when the tax was introduced for water, resulting in positive and significant difference-in-differences point estimates for juice in row "Juice*Tax Intro* WA." We reject that hypothesis, as quantity for juice dropped in Washington by 3.1% relative to control states during the tax introduction, as can be seen in the row labeled "Juice*Tax Intro*WA."

In the triple difference with juice, we find that water sales dropped significantly due to the tax introduction (by 2.8%) once we account for all controls and net price. Using non-dairy milk substitute as the comparison category, however, we see that the triple-difference estimates a reduction of 4.9% given that the difference-in-differences average treatment effect point estimate for non-dairy milk substitutes is positive.

Looking now at the effect of the tax's removal on water sales, we find different results when using juice or milk substitutes as a control category. Looking at the triple-difference point estimates ("Triple Difference Tax Removal"), there appears to be no statistically significant effect for water sales in the post-tax period relative to juice. However, when comparing water sales to sales of milk substitutes, the triple-difference effect of the tax imposition remains intact after the tax removal. This suggests that in a triple-difference framework, the treatment effect on bottled water sales rebounds somewhere between "completely" and "not at all" when the tax is removed. In all cases, the post-tax treatment effect on water sales is weakly negative.

We note that many juice products are, like water, packaged in plastic bottles while milk substitutes are frequently sold in other packaging. Since the campaign for Washington's tax initiative mentioned the environmental problems of plastic, it is possible that juice in plastic bottles was also indirectly affected by the tax and the subsequent campaign to rescind it. This insight makes us more confident in the results from our triple-difference specification that uses milk substitutes as a control category compared to the specification that uses juice.

The results from the difference-in-differences specification as well as the triple-difference specifications show that when the tax on bottled water was introduced in Washington, there was a significant drop in bottled water sales relative to the control states, and that the drop in sales was not reversed, even in later periods after the tax was removed.

Conclusion

This article uses a detailed product-store level scanner dataset of quantity sold over time and space to measure the quantity response to the introduction of a tax on bottled water purchases. Table 9 summarizes the treatment effect of this tax and its removal on bottled water sales for all the approaches examined in this paper. We estimate a 2.8% to 5.9% drop in bottled water consumption in response to a tax of between 6.5% and 9.5%. This implies that demand for bottled water is inelastic. Therefore, significant revenue can be raised from taxing bottled water without causing large deadweight losses. However, the low price elasticity means that a very high levy would be necessary to change the behavior of buying bottled water. The number of plastic water bottles saved per year by the tax in this grocery chain is about 143,000, while the total number of bottles sold by the chain per year is over 2.43 million.[11] This suggests that taxing water bottles is not likely to have measureable environmental effects.

On the rescission of the tax increase, the quantity of bottled water sold returned to its pre-tax level, at least when the change in water sales in Washington are compared to both the change in sales in neighboring states and to the sales of one of the comparable categories, namely juice. When only compared to sales in neighboring states, or compared to milk substitutes, water bottle sales remain below their baseline level. We would expect sales after rescission to be lower than sales before the tax increase because people who switch their buying habits do not necessarily switch back when prices come back down.

Not all consumers react alike to the bottled water tax. Those in the higher-income and lower-income neighborhoods in our sample have the largest responses to the tax. We think this is because the lower-income neighborhoods are simply more price-responsive than the average population. As for the higher-income neighborhoods, our findings are consistent with them reacting to the tax's implicit environmental message.

Interestingly, in this study, the triple-difference effect estimate based on a comparison with juice (but not non-dairy milk substitutes) was much smaller than the difference-in-differences estimate. This discrepancy shrinks somewhat when we restrict our juice triple-difference analysis to the same set of stores used in the milk substitute triple difference. The triple difference controls for a process that varies by time and store. If there were only time and store differences, the results for milk substitutes and juice would be the same, which they are not. One possibility is that the tax and associated campaign in Washington succeeded in stigmatizing plastic bottles, so that juice was partially treated by the tax and hence its quantity fell. Milk substitutes, which are frequently not packed in plastic, then remained unaffected by the tax.

When one compares Washington's bottle tax to the deposit and refund schemes of neighboring states, the deposit and refund schemes are more targeted to controlling waste and much more effective at it. California's scheme has the most transparent cost structure as it is a special state fund. The money from the 30% of unredeemed bottles is the funding source.[12] In rough numbers, a water bottle bought in bulk costs 20¢ and it costs 1.5¢ (30% of the 5¢ recycling value, or 7.5% of its costs, to cause its return with a 70% probability). In contrast, a tax of 7.5% reduces bottles by a mere 6% or so. It thus very clearly matters whether an environmental tax closely targets the environmental benefit.

Supplementary Material

Supplementary material is available at http://oxfordjournals.org/our_journals/ajae/.

References

Barnes, D., F. Galgani, R. Thompson, and M. Barlaz. 2009. Accumulation and Fragmentation of Plastic Debris in Global Environments. *Philosophical Transactions of the Royal Society B* 364 (1526): 1985–98.

California Department of Resources Recycling and Recovery. 2013. Beverage Container Recycling. Available at: http://www.calrecycle.ca.gov/BevContainer.

———. 2013. *Biannual Report of Beverage Container Sales, Returns, Redemption, and Recycling Rates*. Sacramento CA.

Christensen, R. 2013. Former Nestle CEO Wants World Water Supply under Corporate Control. *Addicting Info*. Available at: http://www.addictinginfo.org/2013/05/19/ceo-nestle-water-privatized-corporate-control.

Chetty, R., A. Looney, and K. Kroft. 2009. Salience and Taxation: Theory and Evidence. *American Economic Review* 99 (4): 1145–77.

[11] We calculate this as follows: average number of units in a UPC sold per store-week*average number of UPC's per store*number of bottles per UPC sold*52 weeks*170 stores*percentage reduction from the tax.

[12] The recycling rate for PET was 70% in 2012. See the Biannual Report of Beverage Container Sales (California Department of Resources Recycling and Recovery 2013).

Fletcher, J., D. Frisvold, and N. Tefft. 2015. Non-linear Effects of Soda Taxes on Consumption and Weight Outcomes. *Health Economics* 24: 566–82.

———. 2010. The Effects of Soft Drink Taxes on Child and Adolescent Consumption and Weight Outcomes. *Journal of Public Economics* 94 (11–12): 967–74.

Flores-Lagunes A., and T. Timko. 2014. Does Participation in 4-H Improve Schooling Outcomes? Evidence from Florida. *American Journal of Agricultural Economics* 97 (2): 414–34.

Garber, A. 2010. D.C. Group Backs Washington State Initiative to Nix New State Taxes on Pop, Candy. *The Seattle Times*. Available at: http://www.seattletimes.com/seattle-news/dc-group-backs-washington-state-initiative-to-nix-new-state-taxes-on-pop-candy/.

Gleick, Peter. 2010. *The Story Behind Our Obsession with Bottled Water*. Covelo: Island Press. pp. 94–95.

Gregoire, C. 2010. A Balanced Approach to Hard Times. A letter to Speaker of the House Frank Chopp, et al. Olympia, Washington: Office of the Governor. Available at: http://blogs.sos.wa.gov/FromOurCorner/wp-content/uploads/2010/02/Feb_17_2010_packet.pdf.

Hossain, T., and J. Morgan. 2006. …Plus Shipping and Handling: Revenue (Non) Equivalence in Field Experiments on eBay. *B.E. Journals in Economic Analysis and Policy: Advances in Economic Analysis and Policy* 6 (2): 1–27.

Imbens, G., and D. Rubin. 2015. *Causal Inference for Statistics, Social, and Biomedical Sciences: An Introduction*. New York: Cambridge University Press.

Imbens, G., and J. Wooldridge. 2009. Recent Developments in the Econometrics of Program Evaluation. *Journal of Economic Literature* 47 (1): 5–86.

La Corte, R. 2010. Beverage Tax Battle Leads Spending. The News Tribune. Available at: http://www.thenewstribune.com/2010/10/29/1400617/beverage-tax-battle-leads-spending.html.

Nestle Waters. 2013. Key Facts and Figures. Available at: http://www.nestle-watersna.com/en/about-nestle-waters/key-facts-and-figures.

Okrent, A., and J. Alston. 2011. *Demand for Food in the United States*. Giannini Foundation Monograph 48, Berkeley, California.

Oregon Liquor Control Commission. 2013. The Bottle Bill and Redemption Centers. Available at: http://www.oregon.gov/OLCC/Pages/bottle_bill.aspx.

Powell, L., J. Chriqui, and F. Chaloupka. 2009. Associations between State-level Soda Taxes and Adolescent Body Mass Index. *Journal of Adolescent Health* 45 (3): S57–S63.

Sturm, R., L. Powell, J. Chriqui, and F. Chaloupka. 2010. Soda Taxes, Soft Drink Consumption, and Children's Body Mass Index. *Health Affairs* 29 (5): 1052–8.

Ravallion M., E. Galasso, T. Lazo, and E. Philipp. 2005. What Can Ex-participants Reveal about a Program's Impact? *Journal of Human Resources* 40 (1): 208–30.

Virgin, B. 2007. Bottle Deposits Idea Could be Recycled, Seattle pi. June 11. Available at: http://www.seattlepi.com/news/article/Bottle-deposits-idea-could-be-recycled-1240215.php.

Washington State Department of Revenue. 2010. Local Sales and Use Tax Rates and Changes. Available at: http://dor.wa.gov/Docs/forms/ExcsTx/LocSalUseTx/LocalSlsUseFlyer_10_Q4.pdf.

———. 2010. Tax Facts. Olympia.

Zhen, C., E. Finkelstein, J. Nonnemaker, S. Karns, and J. Todd. 2014. Predicting the Effects of Sugar-sweetened Beverage Taxes on Food and Beverage Demand in a Large Demand System. *American Journal of Agricultural Economics* 96 (1): 1–25.

Zheng, Y., E. McLaughlin, and H. Kaiser. 2013. Taxing Food and Beverages: Theory, Evidence, and Policy. *American Journal of Agricultural Economics* 95 (3): 705–23.