

Measuring Consumer Responses to a Bottled Water Tax Policy

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ABSTRACT.

Using panel data of retail purchases, we measure the effects of a bottled-water tax introduction, and later removal, in the state of Washington. We use a triple difference approach to measure effects against untreated stores (in a control comparable state), untreated products (other bottled beverages), and untreated weeks (pre- period). The results show that, when the tax was imposed, it caused bottled water sales to drop. This sales' drop never picks up, even after the tax removal. Looking at the heterogeneity, we find larger quantity drops, the higher the tax rate, and in the lowest and highest quintile income areas.

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1. Introduction

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 PET bottle litter with a refund and deposit system: both California and Oregon have a 5 cent deposit² on bottled water, resulting in a 2012 recycling rate of 70 percent of eligible PET bottles in California.³ 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 the negative environmental impact. This paper examines the effect of this disposable water bottle tax on disposable water bottle sales.

Water bottles, mostly lightweight polyethylene terephthalate (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 both domestic and wild animals. When they reach the ocean, they become part of a large collection of plastic, deleterious to marine life.⁴ Groups opposed to the use of plastic water bottles also cite the use of petroleum in their manufacture and the municipal waste load. On these grounds, there is an economic argument supporting some measures to limit their production and

² http://www.oregon.gov/OLCC/Pages/bottle_bill.aspx and <http://www.calrecycle.ca.gov/bevcontainer/>. These rates apply in California for containers under 24 oz. Larger containers have a 10c deposit.

³ <http://www.calrecycle.ca.gov/bevcontainer/Notices/2013/Biannual.pdf> 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.

⁴ See Barnes et al. (2009) for a description of the extent of plastic accumulation and potential harm, particularly in marine ecosystems.

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.⁵ While the last concern may have considerable political legs, imperfect competition in bottled water does not seem to be a pressing economic problem.⁶

The use of market based initiatives to control externalities has been understood since Pigou. In the United States, among the first market based initiatives were the Oregon bottle bill (a deposit return program) and the SO₂ trading scheme within the Clean Air Act. Since then, there have been many important market based initiatives, including RECLAIM in Southern California, REGGI in the northeast, Swedish environmental taxes, the EU ETS, ten other bottle bill state laws, and more.⁷ The Washington bottle tax is in this tradition, though not as well targeted toward litter as are deposit return programs. In each of these cases, the key economic parameter is the price elasticity of abatement. For a cap and trade program, the price elasticity determines the cost of the program. For a tax program, like the WA bottle tax studied here, the price elasticity 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

⁵ 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 upon by many bloggers and journalists, for instance, Christensen (2013).

⁶ The Herfindahl index for bottled water is 1650, well below the threshold in the merger guidelines. The source is a 2011 market share chart credited to The Beverage Marketing Corporation and available at <http://www.nestle-watersna.com/en/about-us/industry-overview/beverage-consumption-sales>. Accessed June 25, 2013.

⁷ RECLAIM is the Regional Clean Air Initiative Market in the South Coast Air Quality Management District in California. It trades nitrogen and sulfur oxides emission permits. REGGI is the Regional Greenhouse Gas Initiative that trades greenhouse gas emissions entitlements in the U.S. Northeast. The EU ETS is the European Unions emissions trading scheme and also trades greenhouse gas emissions entitlements.

coin is that a low elasticity leads to high revenue, which was one of the aims of the Washington tax.

Using a rich panel dataset of retail consumer purchases from one national retailer, we measure the effects of a recent tax policy change on bottled water, where a tax was first introduced and later removed in Washington state. The tax rate imposed was different in different Washington localities. We use comparable treatment stores and control stores, based on pre-treatment observable store characteristics, sales, promotion sensitivity, and consumer demand characteristics. This allowed 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. We further assess whether consumer changes are persistent over time. In our empirical research design, we look at the purchase of bottled water, as well as bottled juice, which is a comparable category, although not an exact substitute, and was not subject to tax changes. We use a triple difference approach to measure treatment effects against untreated stores (in locations without a tax change, i.e., a control comparable state), untreated products (another bottled beverage), and untreated weeks (in the pre-treatment period).

Sales taxes are not explicitly shown in the displayed price of an item. Rather, they are added at the time of purchase. The same is true for shipping costs. Such additions to price are termed non-salient. There is a small but growing literature that empirically shows that consumers have an attenuated response to non-salient costs; in other words, they are less sensitive to non-salient costs than to increases in the displayed price. With a labeling experiment, Chetty et al. (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. While the Washington tax on bottled water was not visible on the supermarket shelf, opponents of the tax began a campaign to repeal it even before it was implemented. They spent \$16.5 million to inform voters about the water bottle tax, as well as other taxes. The repeal campaign debated the costs to consumers relative to the benefits of tax revenues for schools, with little focus on environmental issues. Thus, this tax was much more salient than most tax changes. Therefore, the change in sales incident upon the change in the sales tax gives a good indication of the efficacy of a market based approach to controlling an externality caused by a consumer product.

Our results are as follows: when taxed, the average quantity of bottled water purchased in treated states drops significantly, by 6.4 percent, as compared to the untaxed control states. When compared to juice consumption upon the imposition of the water tax (for a triple difference), the drop becomes 3.2 percent. Even after the tax is removed, water consumption remains 3.6 percent lower than the baseline, though juice consumption is similarly reduced, resulting in a triple difference effect of zero in the tax removal case.⁸ 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 the lowest and highest quintiles of income experienced the largest statistically significant reductions in quantity.

The rest of the paper proceeds as follows. Section 2 describes the institutional background. Section 3 describes the empirical setting and summarizes the data, while Section 4

⁸ These values come from Table 6, specification (v).

outlines the research design and empirical strategy. Section 5 presents the results and Section 6 concludes.

2. Institutional Background

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 percent voting no.⁹ 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 “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.”¹⁰ The law was calculated to bring revenue of about 100 million dollars per year and the bottled water tax was specifically projected to provide 32.6 million dollars. As soon as the governor’s ink was dry on the rescission, the American Beverage Association (ABA) gathered signatures and filed for a referendum on the increased tax, creating Initiative Measure 1107.¹¹ Groups in favor of the repeal spent \$16,042,629 in campaign money to repeal the measure, almost all coming from American Beverage Association.¹² The

⁹ For a history of the regulation of bottles in Washington, see <http://www.seattlepi.com/news/article/Bottle-deposits-idea-could-be-recycled-1240215.php>

¹⁰ Exemptions from sales tax for food and like items are common. In California, bottled water is exempt from taxation. The Washington law can be found at <http://apps.leg.wa.gov/rcw/default.aspx?cite=82.08.0293>

¹¹ Garber, Andrew. "D.C. Group Backs Washington State Initiative to Nix New State Taxes on Pop, Candy | Seattle Times Newspaper." *The Seattle Times / Seattle Times Newspaper*. 18 June 2010. Web. 15 Oct. 2010. <<http://seattletimes.nwsourc.com/cgi-bin/PrintStory.pl?documentid=2012146608&zsectionid=2003904401&slug=initiative18m&date=20100617>>.

¹² Rachel La Corte, “Beverage Tax Battle Leads Spending.” *The News Tribune* Oct. 29, 2010. <http://www.thenewstribune.com/2010/10/29/1400617/beverage-tax-battle-leads-spending.html>

campaign against the repeal spent a meager \$426,828.¹³ Initiative 1107 succeeded on November 2, 2010, restoring the sales tax exempt status of bottled water effective December 2, 2010.¹⁴

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 percent 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 percent to a high of 9.5 percent.

3. Empirical Setting and Data

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 sales of grocery products in the U.S. 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 (1) the layout of stores is very uniform across stores, (2) the promotional effort is common for all stores, (3) highlighted products are the same across stores, and (4) posted prices are also common across stores.

From the retailer, we obtained a panel data set of store-level weekly sales at the product-version (UPC) level for two categories, juice and water. An observation is the total

¹³ La Corte, op cit.

¹⁴The initiative also restored the tax exempt status for gum and candy and repealed the 2c per 12 oz. tax on soda. Department of Revenue, Washington State. *Impacts of 1107*. <http://dor.wa.gov/content/getaformorpublication/publicationbysubject/taxtopics/1107.aspx>. Accessed June 15, 2013.

revenue and total quantity sold of a particular UPC in a particular week in a particular store. The raw data on revenue is two columns (net and gross) that are equal to each other if the product was not on promotion during a certain week in a certain store. Those two revenue columns will differ if there are promotions: the net column will feature a smaller dollar value than the gross column. If we then divide both revenue variables by the quantity sold, we obtain the gross shelf price and the promotional price. All stores in the treatment and control belong to the same price division. The price division is a division of the retailer in which shelf prices are the same and promotions are the same across all stores; when prices change, they all change on the same Tuesday for all stores in the sample.

We obtained data for all stores in the same division in 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.

For each product, we know which category it belongs to. Within the store treatment control category, the water category was treated (subject to tax changes) and all other bottled juice beverages were untreated. Table 1 presents summary statistics for log of quantity, shelf price, number of stores, and number of products sold. These are presented for four cases defined by water in control, water in treated, juice in control and juice in treated stores. Each of these cases is examined in three time periods: pre-period, tax period, and tax removal period.

Table 1. Summary Statistics of Treated and Control Product Categories

TIME PERIOD	VARIABLE	WATER		JUICE	
		CONTROL STORES	TREATED STORES	CONTROL STORES	TREATED STORES
PRE-TAX PERIOD	LOG(Q)	2.03	2.16	1.14	1.22
	GROSS PRICE	2.74	2.78	3.61	3.62
	NUMBER OF STORES	107	170	107	170
	NUMBER OF UPC IDS	68	74	239	248
TAX POLICY PERIOD	LOG(Q)	2.16	2.23	1.14	1.22
	GROSS PRICE	2.33	2.35	3.39	3.39
	NUMBER OF STORES	104	166	104	166
	NUMBER OF UPC IDS	63	71	171	216
TAX REMOVAL PERIOD	LOG(Q)	2.00	2.10	1.14	1.22
	GROSS PRICE	2.47	2.48	3.41	3.44
	NUMBER OF STORES	103	166	103	166
	NUMBER OF UPC IDS	76	82	198	207

Source: Authors' calculations from scanner data.

From Table 1, just by looking at the simple averages of the variables of interest, we see changes in average quantity that are contemporaneous with the tax policies, while firm level strategic variables, such as price, remain unchanged across the treatment and control groups. Looking first 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 taxed stores. Where it does change from period to period, price changes similarly for the treated stores

and control stores.¹⁵ Second, looking at the number of stores we observe some exit, but the exit occurs both in the treated and in the control regions.

In terms of quantity and number of products (UPC) bought by consumers, we find the following facts that motivate us to use a formal regression analysis to further investigate the responses to tax and tax removal. We note that, since the quantity is in log format, differencing across periods for each column gives us the percent change in quantity coincident with the tax changes. We see several interesting patterns in the simple differences in means without accounting for any controls: (i) Comparing the first panel (PRE-TAX PERIOD) with the middle panel (TAX POLICY PERIOD), we see that the control stores' average quantity increased by twelve percent during the period of the tax introduction, while the treated stores' average quantity increased by only six percent, which would imply a six percent negative difference in means effect due to the tax introduction. (ii) when the tax is removed, comparing average quantity in the third panel (TAX REMOVAL PERIOD) with the first panel (PRE-TAX PERIOD) we see that quantity dropped by three percent in the control stores, while in the treated stores quantity dropped by six percent. Comparing the middle panel to the third panel, we also see that quantity dropped more in the control stores during the period of tax removal (by 15 percent) than the drop in the treated stores during the same period (a 12 percent drop). Taken together, these two sets of differences-in-means point to consumption rebounding a bit in the

¹⁵ The average price reported is over all products sold. If not all products sold are the same the average price reported can differ (e.g., from Table 1, the average computed price in pre-period in the control stores is 2.74, while it is 2.78 in the treated stores). We note though that the difference is economically very small. The posted prices, for products sold and for products available at the time of purchase, but not sold (not in the data) are all the same across all stores in all divisions, and those are the prices that consumers base their decisions on.

treated stores when the tax was removed, as compared to the control stores. However, quantity never returns to the initial level of consumption, and stays further below the pre-tax period levels in the treated regions than in the control regions. (iii) We also take away from the water category part of the table the need to difference out the changes contemporaneous with the tax; these changes are seen in the control group, so that looking just at the treated stores leads to a biased estimate of the tax policies. (iv) Finally, for the juice category, quantity sold and prices are basically unchanged during the tax introduction and subsequent policy removal. In sum, the table shows that a formal difference strategy is called for.

The next step is to use the pre-treatment period data to investigate 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. As the match becomes less exact it becomes more important to take advantage of the panel structure of the data. The panel allows one to control for (1) differences in treated and control stores in the other state and (2) differences in treated category and the untreated, within treated stores, control juice category, and (3) differences in season. These controls are implemented with (1) product-store fixed effects that will control for observed and unobserved constant differences in determinants of demand at the product store level and (2) by including seasonal week fixed effects that are common to all products.

Table 2 presents summary statistics for the treated stores and control stores for the water category and for the control juice category (used in the triple differences specification) using data only for the pre-policy period, that is, until June 1, 2010.

Table 2. Treated and Control Stores and Product Categories in the Pre-Period

Variables	Water			Juice		
	Control Stores	Treated Stores	p value of Difference	Control Stores	Treated Stores	p value of Difference
Average (log (Q))	2.03	2.16	0.0000	1.14	1.22	0.0000
(std)	(1.30)	(1.38)		(1.00)	(1.01)	
Average Gross Price	2.74	2.78		3.61	3.62	
(std)	(2.05)	(2.10)		(1.38)	(1.33)	
Average Net Price	2.41	2.47		3.24	3.29	
(std)	(1.77)	(1.83)		(1.32)	(1.31)	
Median Income (\$)	40698.39	46722.76	0.0000	40698.39	46722.76	0.0000
	(9728.65)	(12258.94)		(9728.65)	(12258.94)	
Building Size (sq ft)	44439.77	46713.71	0.1256	44439.77	46713.71	0.1256
	(12058.77)	(11865.69)		(12058.77)	(11865.69)	
Selling Area (sq ft)	30811.67	31950.93	0.2952	30811.67	31950.93	0.2952
	(8973.73)	(8509.37)		(8973.73)	(8509.37)	

Source: Author's Calculations from the scanner data. Income originates from the 2000 Census Data.

While treated stores have higher quantities sold and higher median incomes on average compared to control stores, the sample averages for each are 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 depicting in the vertical axis average quantity sold by week (in the x axis) during the pre-period and during the tax introduction period, highlighted by the red vertical line in week 178, we find there to be no significant differences in trends in Washington State compared to control states.

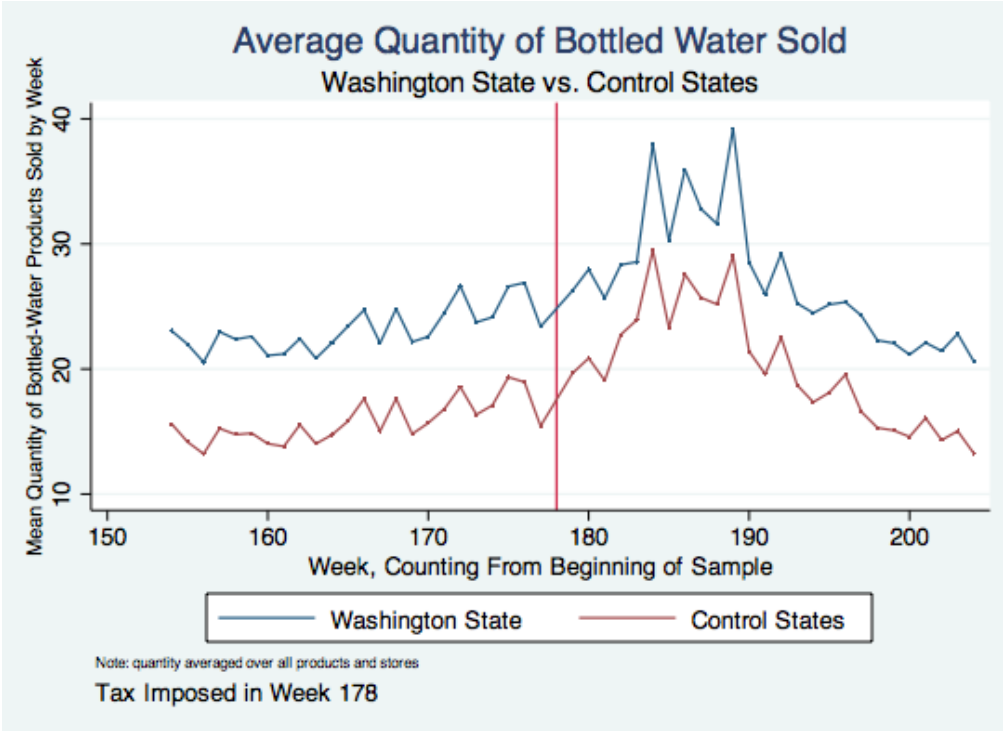


Figure 1. Average Quantity of Water Sold over the Weeks in the Data

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.

4. Empirical Strategy

Our empirical strategy to estimate the average effect of the tax change on quantity sold is to consider stores in the tax changing state to be treated stores and stores in the neighboring state to be the control stores.

We use comparable treatment stores and control stores, based on pre-treatment 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. We can further assess whether consumer changes are persistent over time.

In our empirical research design, we look at the purchase dataset for bottled water, as well as the behavior for juice, a related but not completely substitute category, typically stocked by retail store in the U.S. We also use a triple difference approach to measure treatment effects against untreated stores (in locations without a tax change, i.e., a control comparable state), untreated products (juice beverages), and untreated weeks (in the pre-period). Our results show that when the tax was introduced, there was a significant drop in bottled water sales relative to the controls, and that drop in sales was not reversed, even in later periods after the tax is removed.

Because localities in Washington have different sales taxes from each other, as described in Table 3, the tax rates are different in different stores. The table shows that, other than the two stores with a rate of 6.5 percent, the stores had a tax rate of between 8 and 9.5 percent. These differential levels of taxes will allow us not only to estimate the average treatment effect of a tax change, but also heterogeneity with respect to the tax level.

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

Tax Range	Number Stores with that 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, http://dor.wa.gov/Docs/forms/ExcsTx/LocalSalUseTx/LocalSIsUseFlyer_10_Q4.pdf Accessed 9/2/2013.

NOTE: these are tax range floors, so the first bin is [0.065, 0.07).

4.1. Difference-in-Difference Empirical Specifications

We utilize a difference-in-difference and, in the next section, a triple difference approach to find the effect of the tax changes on the quantity sold. In the 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 by week and by store for each product. So 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 rescinded, and in the neighboring states of Oregon and Idaho, where there was no tax change. The dummy variable T_{is} is 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 rescinded, when r is nonzero. We call these periods "pre," "during," and "rescind." For the triple difference specification, we use products with a tax change (bottled water) and products without a tax change (juice). The variable O_i is one for treated products.

There are three difference-in-difference specifications, with increasing levels of controls. Writing quantity as a function of store type (treated or not) and time period (during or pre), the treatment effect is symbolically given by:

$$D-D = [\ln Q (\text{Treated, During}) - \ln Q (\text{Treated, Pre})] - [\ln Q (\text{Untreated, During}) - \ln Q (\text{Untreated, Pre})].$$

Substituting "removed" for "during" gives the estimate for the treatment effect of rescinding the tax relative to the base period. Finally, the triple difference is realized evaluating (2) for water, $DD(\text{water})$ and for juice, $DD(\text{juice})$ and forming $DDD = DD(\text{water}) - DD(\text{juice})$.

We start by running the following difference-in-differences regression, using only data on water products:

$$(1) \ln Q_{isw} = \beta_0 + \beta_1 T_{is} + \beta_2 t_{iw} + \beta_3 T_{is} t_{iw} + \beta_4 r_{iw} + \beta_5 T_{is} r_{iw} + \varepsilon_{isw}.$$

The coefficient on T_{is} is a treatment group specific effect, and 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. Although useful for examining the average treatment effect of the tax change on the treated water categories, specification (1) 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, we include dummy variables for products interacted with individual store dummies, as well as the weekly price.¹⁶:

$$(2) \ln Q_{isw} = \alpha_{is} + \beta_0 + \beta_1 T_{is} + \beta_2 t_{iw} + \beta_3 T_{is} t_{iw} + \beta_4 r_{iw} + \beta_5 T_{is} r_{iw} + \beta_6 p_{iw} + \varepsilon_{isw}$$

where α_{is} denotes store-product fixed effects to control for store-product-specific constant factors and p_{iw} contains the price variable, which is a continuous variable normalized by container size.

¹⁶ When comparing the point estimates with and without price and store-product controls, we find no significant differences, which reassures us that our experimental design is valid based on observable characteristics in the treatment and in the control stores. Also, prices did not react to the tax policy, as can be seen in the Table in the results section.

Finally, we add week fixed effects α_w to the specification given by equation (3) to control for seasonal-weekly level changes that are common across all stores and regions, as well as year by quarter fixed effects denoted by α_{y-q} . This is going to be the preferred specification to interpret the difference-in-difference results of the tax introduction, and later of the tax removal and is given by:

$$(3) \ln Q_{isw} = \alpha_{y-q} + \alpha_w + \alpha_{is} + \beta_0 + \beta_1 T_{is} + \beta_2 t_{iw} + \beta_3 T_{is} t_{iw} + \beta_4 r_{iw} + \beta_5 T_{is} r_{iw} + \beta_6 p_{iw} + \varepsilon_{isw}$$

4.2. 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 (3). Specification (4) 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

$$(5) \ln Q_{isw} = \alpha_{y-q} + \alpha_w + \alpha_{is} + \beta_0 + \beta_1 T_{is} + \beta_2 t_{iw} + \beta_3 O_i + \beta_4 T_{is} t_{iw} + \beta_5 O_i * T_{is} + \beta_6 O_i * t_{iw} + \beta_7 O_i * t_{iw} * T_{is} + \beta_8 p_{iw} + \beta_9 r_{iw} + \beta_{10} T_{is} r_{iw} + \beta_{11} O_i * r_{iw} + \beta_{12} O_i * r_{iw} * T_{is} + \varepsilon_{isw} .$$

As with the difference-in-difference specifications, we estimate this with and without the additional fixed effects and price variable.

4.3. Empirical Specifications Considering Heterogeneity

Further, we will estimate specifications in which we allow each treatment to have a different effect on each tax region, as the tax changes differed by “regions,” as well as allow the treatment to vary according to the demographics in the store locations. We do this by modifying specification (3) for the difference-in-difference and specification (4) for the triple difference, where we add heterogeneity according to the tax level and income by allowing the coefficients of interest to vary according to the tax level and also by the income level in the area in which the store is located.

5. Results

We will first present the average change in the quantity of bottled water purchased in response to tax and tax-removal, based on the difference-in-difference identification strategy. Next, we will compare the change in the quantity of bottled water purchased to the change in the quantity of bottled juice purchased, using the triple difference identification strategy. Then we will investigate whether responses differed for stores serving different demographic areas. We will also take advantage of the differential tax levels to assess differential responses.

5.1. Average Effects of the Tax Policy and later Tax Removal

We start with the difference-in-difference specification which compares water sales changes in treated stores to those changes in control stores. The results are presented in Table 4, which is organized as follows. The log of quantity sold is the dependent variable in all regressions. The first Column (i) reports the results from the specification of Equation (1) where

the independent variables are a constant, the treatment stores' (in the row titled Washington) indicator, the tax introduced time dummy (in the row titled Tax Introduced), the tax removed time dummy (Tax Removed) and the interaction of the two time dummies and the treatment store dummy (Washington*Tax Introduced and Washington*Tax Removed.) It is these interaction terms that correspond to the tax policy average treatment effect point estimate. Column (ii) performs the same regression but adds product-by-store fixed effects, Column (iii) adds seasonal fixed effects to the specification in the previous column by adding weekly dummies and year by quarter dummies, Column (iv) adds shelf gross price (Gross Price) to the specification in Column (iii) and finally in Column (v) we report the estimates for the same specification as in Column (iv) 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. We include specifications with gross price for completeness.

Table 4. Results for Difference-in-Difference Regression in the Water Category

Variables	Dependent Variable for all columns is Log (Quantity of a product)				
	(i)	(ii)	(iii)	(iv)	(v)
Constant	2.033*** (0.00)	2.147*** (0.07)	2.155*** (0.07)	2.347*** (0.07)	3.360*** (0.07)
Washington (WA)	0.131*** (0.00)	-0.0421 (0.11)	-0.0431 (0.11)	-0.0297 (0.11)	0.0532 (0.10)
Tax Introduced	0.122*** (0.00)	0.0739*** (0.01)	0.00661 (0.01)	0.00969 (0.01)	-0.00528 (0.01)
Tax Removed	-0.0300*** (0.00)	-0.0373*** (0.01)	-0.00486 (0.01)	-0.00246 (0.01)	-0.0339*** (0.01)
Tax Intro * WA	-0.0591*** (0.00)	-0.0438*** (0.01)	-0.0414*** (0.01)	-0.0443*** (0.01)	-0.0619*** (0.01)
Tax Removed * WA	-0.0318*** (0.00)	-0.0263*** (0.01)	-0.0254*** (0.01)	-0.0248*** (0.01)	-0.0357*** (0.01)
Net Price					-0.507*** (0.01)
Gross Price				-0.0725*** (0.01)	
Product-Store Fixed Effects	No	Yes	Yes	Yes	Yes
Time Fixed Effects	No	No	Yes	Yes	Yes
R squared	0.003	0.002	0.039	0.04	0.116
Number of Observations	3,949,346	3,949,346	3,949,346	3,949,346	3,949,346

Source: Author's Calculations from the scanner data.

*** p<0.01, ** p<0.05 , * p<0.1 level

Robust standard errors in parentheses.

Time Fixed Effects include weekly dummies and quarter by year dummies.

From the Table 4 results, we see that consumers purchased on average 13 percent more quantity per product of water in Washington than in the control state, as shown by the first column estimates in the row “Washington (WA).” However, when we control for products and stores and seasonal determinants of water consumption, as shown in the remaining columns, Washington does not have significantly different average consumption from the controls. When looking at Column (iii) with product store and seasonal controls, and also when controlling for gross price in Column (iv), we see that during the tax introduction weeks (row “Tax Introduced”), quantity did not significantly change; neither did it significantly change during the removal weeks (“Tax Removed” row). When we control for net of discount prices in Column (v), however, we see that, although quantity did not change during tax introduction, it did drop significantly during the time of the tax removal, by about 3.4 percent.

Looking now beyond the first differences of the previous paragraph, starting first with a pure difference-in-difference without fixed effects in Column (i) we estimate there to be a significant drop in quantity sold, by 5.9 percent, due to the tax introduction, given by the coefficient associated with the interaction in row “Tax Intro * WA,” as well as a 3.2 percent 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 (ii) for fixed effects at the product store level, in Column (iii) for weekly seasonal effects, and then in (iv) for shelf prices, we find a significant, but smaller in magnitude effects, of the tax introduction and tax removal as compared to the pure OLS specification in Column (i). In Column (v), controlling for net of discount prices, we find a larger significant drop of 6.2 percent for the tax introduction period relative to the baseline pre-period quantity, as well as a significant drop of 3.6 percent for the tax removal policy period relative to the baseline pre-period average quantity. The take-away from

Table 4 is that the average treatment effect for the tax introduction is in the range of 4.1 to 6.1 percent, and for the tax removal the average treatment effect shows that the quantity never fully rebounded, as it dropped relative to baseline by about 2.5 to 3.5 percent. However, prices may have played a role in explaining the changes, as the point estimates increase in magnitude when we control for net of discount prices, while they are robust to controlling for shelf (gross) prices in the last two columns of Table 4. The evidence suggests that after we control for prices of products people actually buy, that is comparing Column (iii) to (v) we see that quantity dropped significantly by 6 percent during the tax introduction. What this suggests is that not only did quantity drop, but consumers may have switched to products with lower prices.

When looking at what happened to prices of products purchased during the policy changes, we turn to Table 5. The dependent variable is the log of price consumers paid and the right hand side variables are the same as in the specification of Column (iii) of Table 4, controlling for product store level price determinants, weekly seasonal price determinants, and quarter by year price determinants. The first column uses gross shelf price as the dependent variable, while the second column uses the price net of discounts.

We see first that average water prices of products purchased in Washington State (gross and net of discount) are not significantly different than in the control state (the differences are 0.185 in Column (i) and 0.19 in Column (ii) in the baseline period.) Both point estimates are positive, but not significant, which suggests that, compared to the control state, consumers in Washington State stores did not buy higher priced items and also did not buy fewer items on promotion, in the baseline period before any tax policy changes.

Given the retail policy of divisional and advance scheduled pricing policies, we know the set of shelf prices and promotional prices did not change in Washington or in the control states during the tax policy introduction and removal. However, due to the tax introductions and removals, consumer behavior might have changed to buying more or fewer items on promotion. We can investigate whether consumers switched to differently priced items 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 by about 7.9 percent for the gross shelf prices and by about 15 percent for the net prices, as can be seen in the row “Tax Introduced.” During the “Tax Removed” period gross prices increased by 15 percent, while the net prices that consumers paid increased significantly by 27 percent.

The above comparisons are simple before and after differences in prices paid. Now, we turn to the difference-in-difference to investigate whether consumers paid significantly different prices during the tax policy events in the two regions. If they paid different amounts, this would imply that there was substitution to differently priced items, given that we know that posted prices did not change. The findings are that both gross and net prices that consumers paid did change differentially across the treated Washington State, and the control states, when the tax was introduced. This can be seen by the 4 percent significant drop in gross prices and also a drop of similar magnitude in net prices, shown in the row titled “Tax Intro * WA.” What this means is that consumers switched to cheaper shelf price items and also to items on promotion in Washington relative to the control states when the tax was introduced. Looking now at the coefficient associated with “Tax Removed * WA,” we find that gross consumer prices did not change differentially when the tax was removed in the treated states relative to the control states, but that, interestingly, consumers continued to lean toward items on promotion, as the net price

in the treated states did change differentially, by a 2 percent drop, relative to the control states when the tax was removed.

Taken together, we find empirical support that the tax policies made consumers switch to cheaper products, as shown in Table 5, and that this behavior persisted even after the tax was removed. Moreover, after controlling for that product set substitution, as seen in the last columns of Table 4, quantity dropped significantly due to the tax introduction, by about 6 percent, and never rebounded back to pretax levels.

Looking now at the results estimated using the triple difference identification strategy of Equation (5), we turn to Table 6. Table 6 follows the same pattern as Table 5, with five specifications that have the different controls described previously. All specifications include dummies for Juice and Water, and their interaction with the period and place dummies. For table dimension reasons, we do not report all interactions of the variables included in the specifications estimated for Table 6.

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-difference row associated with column “Water*Tax Intro* WA” minus the point estimate of the “Juice*Tax Intro*WA.” Similarly, subtracting “Juice*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 calculations and their t values are reported in the rows Triple Difference*Tax Intro and Triple Difference*Tax Removed.

Water sells more on average than juice, as can be seen in the row corresponding to “Water” in Column (i), which is omitted when we control for product-store fixed effects in the

remaining columns. In general for all specifications, Washington state stores, relative to the control state stores, do not exhibit significantly different average sales for water (in row “Water*WA”). However, juice in Washington stores has significantly larger average sales than controls (in row “Juice * WA”). When the tax 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.”)

Table 5. Results for Difference-in-Difference Regression of Prices in the Water Category

Variables	Dependent Variable is Log (Price of a product)	
	Gross Price	Net Price
	(i)	(ii)
Constant	3.387*** (0.02)	3.074*** (0.02)
Washington (WA)	0.185 (0.17)	0.19 (0.16)
Tax Introduced	0.0787*** (0.01)	0.151*** (0.00)
Tax Removed	0.151*** (0.01)	0.273*** (0.00)
Tax Intro * WA	-0.0405*** (0.01)	-0.0402*** (0.00)
Tax Removed * WA	0.00781 (0.01)	-0.0201*** (0.00)
Product-Store Fixed Effects	Yes	Yes
Time Fixed Effects	Yes	Yes
R squared	0.144	0.047
Number of Observations	22,630,385	22,630,385

Source: Author's Calculations from the scanner data.

*** p<0.01, ** p<0.05 , * p<0.1 level

Robust standard errors in parentheses. Time Fixed Effects include weekly dummies and quarter by year dummies.

Table 6. Results for Triple Difference-in-Difference Regression in the Water relative to Juice Categories

Variables	Dependent Variable for all columns is Log (Quantity of a product)				
	(i)	(ii)	(iii)	(iv)	(v)
Constant	0.796*** (0.01)	1.276*** (0.02)	1.412*** (0.02)	1.843*** (0.02)	2.970*** (0.02)
Water	0.823*** (0.03)	0 0.00	0 0.00	0 0.00	0 0.00
Water*Washington(WA)	0.0255 (0.05)	-0.0421 (0.11)	-0.0418 (0.11)	-0.0182 (0.10)	0.0552 (0.10)
Juice*WA	0.136*** (0.01)	0.164*** (0.02)	0.164*** (0.02)	0.165*** (0.02)	0.182*** (0.02)
Water*Tax Introduced	0.0745*** (0.01)	0.0739*** (0.01)	0.0725*** (0.01)	0.0827*** (0.01)	0.113*** (0.01)
Juice*Tax Introduced	0.0160*** (0.00)	0.0155*** (0.00)	0.00999*** (0.00)	0.0105*** (0.00)	-0.0271*** (0.00)
Water*Tax Removed	-0.0381*** (0.01)	-0.0373*** (0.01)	0.00399 (0.01)	0.0220*** (0.01)	0.0620*** (0.01)
Juice*Tax Removed	0.0143*** (0.00)	0.0137*** (0.00)	0.0525*** (0.00)	0.0499*** (0.00)	-0.0317*** (0.00)
other interactions omitted to save space but in regression					
Water*Tax Intro * WA	-0.0436***	-0.0438***	-0.0429***	-0.0481***	-0.0635***

	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Water*Tax Removed * WA	-0.0254***	-0.0263***	-0.0258***	-0.0249***	-0.0362***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Juice*Tax Intro * WA	-0.0305***	-0.0308***	-0.0305***	-0.0306***	-0.0311***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Juice*Tax Removed * WA	-0.0351***	-0.0352***	-0.0348***	-0.0325***	-0.0347***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Net Price					-0.510***
					(0.00)
Gross Price				-0.127***	
				(0.00)	
Triple Difference*Tax Intro	-0.0131*	-0.013*	-0.012	-0.017**	-0.032***
p value	0.096	0.099	0.113	0.025	0.000
Triple Difference*Tax Removed	0.01	0.01	0.01	0.01	-0.001
p value	0.228	0.273	0.273	0.352	0.853
Product-Store Fixed Effects	No	Yes	Yes	Yes	Yes
Time Fixed Effects	No	No	Yes	Yes	Yes
Number of Observations	22,626,082	22,626,082	22,626,082	22,626,082	22,626,082

Source: Author's Calculations from the scanner data.

*** p<0.01, ** p<0.05, * p<0.1
level

Robust standard errors in
parentheses.

Time Fixed Effects include weekly dummies and quarter by year
dummies.

The novelty in the specifications in Table 6 relative to Table 4 is that we compare the before and after differences in water with the before and after differences in juice. Juice sales do increase during both the tax introduction and removal in all but specification (v), which takes account of net price. When net price is accounted for, the sales of juice drop by 2.7 percent during the tax introduction and 3 percent during the tax removal.

In theory, the tax changes 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-difference juice point estimates in row “Juice*Tax Intro* WA.” Looking at the specification controlling for product store fixed effects, year-quarter effects, and weekly seasonal weekly effects in Column (iii), we reject that hypothesis, as quantity for juice dropped in Washington by about 3 percent relative to control states during the tax introduction, as can be seen in the row labeled “Juice*Tax Intro*WA.”

As a conclusion, and supporting the need to triple difference, we see that juice had a significant drop during the weeks of the tax introduction, although these beverages were not subject to tax. A deviation from seasonal patterns, such as unusually cool temperatures in fall and winter (which were the Tax Introduction periods) could be consistent with the juice findings. Given this concern, we obtain in this triple difference specification a more conservative measure of the effect of the tax introduction on water quantity sold. We do this by subtracting the juice counterfactual changes, which capture seasonality changes in Washington relative to controls, from the water changes. In this case, we subtract “Juice*Tax Intro*WA” from “Water*Tax Intro*WA.” The row labeled “Triple Difference*Tax Intro” reports the point estimates and the p values associated with the difference in water relative to juice. We find that water dropped

significantly due to the tax introduction by 3.2 percent, when all controls and net price are taken into account.

Looking now at the remaining coefficients of interest, we find the effects of the tax removal as compared to the baseline period. Due to the tax removal, we estimate that water and juice consumption dropped by a significant 2 and 3 percent, respectively, in specifications without net price. (See rows “Water*Tax Removed*WA” and “Juice*Tax Removed*WA,” respectively.) We also see that the estimates are robust to store-product controls, seasonal week controls, and gross price controls in Columns (i) to (iv). When controlling for the fact that consumers switched to products with lower prices net of discount, the tax removal point estimate is negative for both water and juice, at about 3.6 percent for water and about 3.5 percent for juice. Performing a triple difference would imply a 0.1 percent drop in quantity relative to the baseline, meaning again that quantity did not fully rebound, even when the tax was removed. However, the estimate for the tax removal average triple difference treatment effect is never statistically significantly different from zero for any specifications in the Table. It is also not statistically different from the tax introduction triple difference point estimate of a 3 percent drop in the same Column (v). This means that, after the tax removal, quantity probably remained below the baseline level and did not rebound to the pre-tax period.

5.2. 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 neighborhood of the treated stores. We start with heterogeneity in the change in taxes. Because different parts of Washington faced different sales tax rates, there is

heterogeneity in treatment, which was described in Table 3. We use tax rate dummy variables to indicate which sales tax bracket a store was in and we assign a zero rate to those stores that were not treated. Table 7 presents six regressions. In the first three columns, the tax rate dummies are interacted with the Tax Intro and Removed dummies, creating 10 treatment effect dummies. The control variables in these regressions correspond to Columns iii-v in Table 4. In the remaining three columns, the tax rate itself is interacted and the controls are the same as in Columns iii-v in Table 4. As the specifications underlying Table 7 have many interaction terms, this table shows only the interactions of interest.\

Table 7. Heterogeneity According to Tax Range- For Water Category

Variables	Dependent Variable for all columns is Log (Quantity of a product)					
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Constant	2.183*** (0.07)	2.380*** (0.07)	3.400*** (0.06)	-1.167 (1.01)	-1.121 (0.96)	-0.929 (0.89)
Tax Rate				38.03*** (11.46)	39.61*** (10.88)	49.34*** (10.04)
Lower Terms Omitted		
Tax Intro *Tax Rate				-4.602*** (0.72)	-4.512*** (0.72)	-4.844*** (0.71)
Tax Removed * Tax Rate				-1.407* (0.72)	-1.254* (0.73)	-1.185 (0.72)

Tax Intro* 6.5%	-0.00834	-0.0192	-0.0396			
	(0.05)	(0.05)	(0.05)			
Tax Intro* 8%	0.0321*	0.0291*	0.0136			
	(0.02)	(0.02)	(0.02)			
Tax Intro* 8.5%	-0.008	-0.0097	-0.0238**			
	(0.01)	(0.01)	(0.01)			
Tax Intro * 9%	-0.0566***	-0.0594***	-0.0793***			
	(0.01)	(0.01)	(0.01)			
Tax Intro * 9.5%	-0.0618***	-0.0635***	-0.0841***			
	(0.01)	(0.01)	(0.01)			
Tax Removed* 6.5%	0.0436	0.0401	0.0221			
	(0.05)	(0.05)	(0.05)			
Tax Removed* 8%	-0.000777	-0.00145	-0.0135			
	(0.02)	(0.02)	(0.02)			
Tax Removed* 8.5%	-0.0167	-0.0166	-0.0285***			
	(0.01)	(0.01)	(0.01)			
Tax Removed * 9%	-0.0502***	-0.0501***	-0.0668***			
	(0.01)	(0.01)	(0.01)			
Tax Removed * 9.5%	-0.0279***	-0.0262***	-0.0384***			
	(0.01)	(0.01)	(0.01)			
Gross Price		-0.0736***			-	
					0.0671***	
		(0.01)			(0.01)	
Net Price			-0.508***			0.0184***
			(0.01)			(0.01)
Product-Store Fixed Effects	YES	YES	YES	YES	YES	YES
Time Fixed Effects	YES	YES	YES	YES	YES	YES

R squared	0.039	-0.0192	-0.0396	0	0	0
Number of Observations	3,949,346	0	0	0	0	0

Source: Author's calculations from the scanner data. Interactions of lower terms omitted to save space.

Notes: Time Fixed Effects include weekly dummies and quarter by year dummies. Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ level.

Looking at the table, the first thing we see is that the highest tax rate sales correspond to observations of the highest quantity sold too, as the coefficients of “Tax Rate” in Columns iv-vi are positive and significant.. Looking at the first three columns, we find that the point estimates associated with the Tax Rates interacted with tax introduction “Tax Intro * X%” are larger for the top tax rates; for the top rates, the estimates are significant and increasing in the size of the tax. Looking at the tax removal point estimates of the tax rate interactions, we find the significant heterogeneity effects, meaning that the areas with the highest tax rates also remained significantly below baseline consumption. Turning now to the continuous tax rate variable interacted with the treatments, in Columns (iv) to (vi) we show similar findings. The higher the tax rate, the larger the drop in quantity, regardless of whether we control for prices. When looking at the tax removal, we again find a significant negative effect for all specifications in terms of the tax rate brackets. Taken together, the evidence presented in Table 7 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 percent results in a 6 to 8 percent drop in quantity sold.

In Table 8, we present results allowing for heterogeneity with respect to the income of the area where the stores are located. We create indicator variables for each of the income quintiles available in the data and interact those indicators with the treatment effect of both tax introduction and tax removal. The national income quintiles pertain to the 2009 classification of the Consumer Expenditure Survey, where the lowest quintile corresponds to \$9,956 after-tax annual household income, the second quintile corresponds to an income of \$27,275, the third quintile to \$45,199, the fourth quintile to \$71,241, and the highest quintile to \$149,951. Table 8 is organized in three columns, where the coefficients of interest refer to the interaction of the treatment variables with indicator variables for the income quintiles of the stores in the data in specification in Column (i). In Column (ii), we additionally control for gross price. In Column (iii), we control for net price.

As in the previous Table 7, because the specifications underlying Table 8 have many interaction terms, this table shows only the interactions of interest. We find that the point estimates associated with the Median Income Quintile dummies interacted with tax introduction “Tax Intro * Income QX” are U-shaped for Column (i), as the drops are largest for both the lowest and highest income quintile (denoted X). The results are robust to controlling for prices. Looking now at the tax removal point estimates of the income quintile interactions, we find that the higher the income quintile, the lower below baseline the quantity remains, even after removal of the tax. So for the higher income quintile areas, quantity not only drops with the tax, even post tax removal quantity never rebounds, and rather stays significantly below the pre-tax baseline period.

Table 8. Heterogeneity According to Income Quintile of the Stores' Neighborhood

Variables	Dependent Variable for all columns is Log (Quantity of a product)		
	(i)	(ii)	(iii)
Constant	2.288*** (0.17)	2.536*** (0.16)	3.832*** (0.16)
Other terms omitted
Tax Intro* Income 2nd Q	-0.0458*** (0.02)	-0.0499*** (0.02)	-0.0657*** (0.02)
Tax Intro* Income 3rd Q	-0.0175* (0.01)	-0.0205** (0.01)	-0.0380*** (0.01)
Tax Intro* Income 4th Q	-0.0410* (0.02)	-0.0449* (0.02)	-0.0683*** (0.02)
Tax Removed* Income 2nd Q	-0.0148 (0.02)	-0.0151 (0.02)	-0.0270* (0.02)
Tax Removed* Income 3rd Q	-0.0117 (0.01)	-0.0114 (0.01)	-0.0227** (0.01)
Tax Removed* Income 4th Q	-0.0806*** (0.03)	-0.0802*** (0.03)	-0.0938*** (0.03)
Gross Price		-0.0744*** (0.01)	
Net Price			-0.509***

			(0.01)
Product-Store Fixed Effects	YES	YES	YES
Time Fixed Effects	YES	YES	YES
R squared	0.04	0.041	0.118
Number of Observations	3,949,346	3,949,346	3,949,346

Source: Author's Calculations from the scanner data. Interactions of Lower terms omitted

to save space. *** p<0.01, ** p<0.05 , * p<0.1 level

Time Fixed Effects include weekly dummies and quarter by year dummies.

Tax rates in WA counties are significantly correlated with population (.28), income (.51), vote for repeal of the sales tax extension (-.67) and 2010 vote for the Democratic candidate for senate (.75). All of these correlation coefficients were calculated across the 83 Washington stores, though the senate vote data is only by county and not by town. The one percent critical value is .283, so all correlations except for population are significantly different from zero at the one percent level; population is significant at the two percent level. In terms of our finding that higher tax rates lead to less bottle use, the higher tax rate localities are richer and more likely to vote Democratic, so they are also more likely to prioritize the internalizing the environmental externalities from water bottle use.

6. Conclusion

This paper uses a detailed product store level scanner data set of quantity sold over time and space to measure the quantity response to the introduction of a tax on bottled water consumption. The estimated 3 percent drop in consumption in response to a tax of between 6.5 percent and 9.5 percent means 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. So 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 pretax state, at least when the change in water sales in the Washington are compared to both the change in sales in neighboring states and to the sales of a comparable category, namely juice. When only compared to the sales in neighboring states they 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 them 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 have the biggest effects. 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 implicit environmental message.

Interestingly, in this study, the triple difference has a much lower effect than the difference in difference. The triple difference controls for a process that varies by time and store. So

consumers changing patronage of stores that is different in Washington and the control state would be picked up in the triple difference.

When one compares the 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. The California 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. In rough numbers a water bottle bought in bulk costs twenty cents and it costs 1.5 cents, or 7.5 percent of its costs, to cause its return with a 70 percent probability. In contrast a tax of 7.5 percent reduces bottles by a mere 3 or so percent. It very clearly matters whether an environmental tax closely targets the environmental benefit.

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