The Incidence of Soda Taxes with Imperfect Information and Strategic Firm Behavior

Hualu Zheng[A] and Lu Huang[B]

[A]Graduate Student

Department of Agricultural & Resource Economics

University of Connecticut

Email: hualu.zheng@uconn.edu

[B]Graduate Student

Department of Agricultural & Resource Economics

University of Connecticut

Email: lu.huang@uconn.edu

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Introduction

The fundamental difference between an excise and a sales tax is how they are implemented. An excise tax is imposed at the production/distribution stage, while a sales tax is collected at the register. The burden of excise taxes tends to be shifted onto consumers and is included in the shelf prices, while sales taxes are usually not shown on the price tag but are added at the register. Excise and sales taxes may influence product demand differently due to their tax natures, particularly in a market with strategic firm behavior in which consumers are imperfectly informed with tax status.

Preponderant empirical studies investigating the effect of taxes on demand address the issue using own and cross price elasticity of demand, and very few of them distinguish between excise and sales taxes. Two fundamental assumptions are made in these studies: 1) passive pricing; that is, firms do not adjust product prices in response to an excise tax, and 2) salient taxes: consumers are perfectly informed with a sales tax. However, both of these assumptions seem unwarranted for many markets. First, the empirical industrial organization literature on pass-through of cost changes concludes that pass-through might be imperfect if the industry is concentrated. In this case, firms price strategically and shelf prices are likely to not fully shift in response of an excise tax change (e.g., Barnett et al., 1995). Second, empirical results show that consumers under-react to taxes that are not salient (e.g., Chetty, Looney, and Kroft, 2009). Because sales taxes are not reflected in the price tag and sometimes are not even stated on receipts, they are not apparent to consumers. Considering firm's strategic prices toward an excise tax and consumer's less awareness of sales taxes, tax elasticity of demand could be a more effective measure for explaining the economic incidence of a sales tax than price elasticity of demand. Furthermore, failing to account for firms' strategic behavior and consumers' imperfect knowledge of taxes leads to a lack of distinction between excise and sales taxes, and results in a biased estimation of tax effects on product consumption.

This paper compares the effects of excise and sales taxes on demand, taking strategic pricing and imperfect tax information into consideration. To address this question, I focus on the U.S. carbonated soft drink (CSD) market. Since this market is highly concentrated at both the processing and retailing levels, the possibility of strategic pricing in response to a tax change is highly likely. Specifically, the following questions are answered: (1) considering the industry is highly concentrated, how does an excise tax pass to the shelf price, (2) considering the sales taxes are mostly not salient to consumers, what is the tax elasticity of demand, and (3) which one is more effective on reducing soft drink consumption, the sales tax or the excise tax? Implications of this paper will help policy makers focus their efforts to address public health problems such as obesity.

The main data employed in this research is Scan Track data obtained from the Nielsen Company. 156 markets covering 6 designated market areas and 26 months from 2010 to 2012 are included in the sample. During the sample period, Atlanta and Boston applied no taxes on CSDs. New York and San Francisco levied no excise taxes but sales taxes on CSDs, with a rate of 8.875% and 9.5%, respectively. Chicago imposed a sales tax at a rate of 9.5% and an excise tax (3%) on retailers selling CSDs. Seattle collected an excise tax from CSD manufacturers at the rate of 2 cents per 12 oz, and a sales tax of 9.5%. The top 15 CSD brands out of the sample are kept in this study.

This paper uses a market level random coefficient discrete choice demand model to estimate consumers' demand of CSDs following the framework of Berry, Levinsohn and Pakes 1995 (henceforth BLP), and Nevo 2000b. Product characteristics (calories, sugar, and sodium) are added to the utility function and are assumed to be exogenously determined, but the prices are correlated with unobserved product characteristics or demand shocks. To control for this endogeneity issue, I use several sets of exogenous instrumental variables, such as cost shifters (manufacturing wage rates, electricity prices, and sugar prices), Hausman-type instruments, and optimal instruments. To account for the salience effects of taxes, sales taxes are separately included in the utility function rather than incorporated into prices. Tax elasticity of demand is obtained based on the salience parameter. I conduct several counterfactual experiments to explore the pass-through of an excise tax and its effects on CSD demand.

This study contributes to the literature in several ways. First, although much research has been done in the area of tax effects, almost all of the analyses are performed with the assumption of a 100% tax pass-through rate. However, this is not the case for most markets. This study helps better understand how firms strategically respond to an excise tax in an oligopoly context. Second, this study empirically tests how tax salience impacts consumer purchase behaviors and the effectiveness of a tax policy. Third, our comparison of excise and sales tax effectiveness will be a useful reference for policy debates concerning which tax policy is the best choice for fighting obesity.

The Soft Drink Market Background

CSDs are the most consumed beverage in the United States. According to the Beverage Digest tracking, soft drinks have outgrown all other beverage categories over the past 27 years. From 1986 to 2012, Americans drank 50.9 gallons of soft drink a year, representing the greatest share of 27.9% of all liquid consumption in the US (Beverage Digest, 2013). Per capita consumption of CSDs kept climbing from 1986 to 1998, at which year it reached the peak of 54 gallons. Due to the arising public concern of obesity and the intense competition, constant decrease in the consumption of CSDs has been witnessed starting from 1998 (Beverage

Marketing Corporation, 2011). Despite the decline, the CSD category still held a leading share of 24% of the average American's total liquid intake in 2012. Meanwhile, Bottled water consumption has been increasing consistently over the last two decades, with an annual per capita consumption rising from 5 gallons in 1986 to 21.9 gallons in 2012. Bottled water has become the second leading segment of non-alcoholic beverages and the most competitive substitute of CSDs, which represented a share of 12% in the liquid refreshment beverages market in 2012 (Beverage Digest, 2013). Figure 1[1] presents per capita U.S. liquid, CSD and bottled water consumption from 1986 to 2012.

The soft drink industry is highly concentrated, with the top three manufacturers sharing over 88% of the total market in 2012 (Coca-Cola about 41%, PepsiCo about 36%, and Dr. Pepper about 12%) (The Statistics Portal, 2013). Additional to national leading brands, relatively low production and marketing cost, and the economic downturn have been a major driver for private label products. Empirical Studies have found that private label soft drinks have expanded their market shares, and as the quality of private labels has improved, they may become more competitive (Batra and Sinha, 2000; Robert et al., etc.).

As soft drinks are considered as one of the major factors contributing to the growing obesity rate, CSDs therefore become a popular political target in the war against obesity, which is taken care of through forms of taxation. Most frequently adopted taxes associated with soft drinks include sales, excise taxes, and tax exemptions. For example, as of January 2011, 32 states have applied sales taxes on soft drinks at an average rate of 5.2%, and four states imposed excise taxes on soda (Arkansas, Tennessee, Virginia, and West Virginia) (Drenkard, 2011). Other than sales tax, excise tax, and exemptions from non-taxable food categories, sodas are considered by lawmakers for an additional soda tax. By 2013, 15 states proposed

[1] Source: Beverage Digest (2013)

an additional soda tax, and some of them put it into effective at state or local levels for various periods of time (Department of Revenue, Washington State, 2010).

The attempt of taxing sodas is for controlling general soft drink consumption, balancing current deficit at both federal and state levels, and offsetting health care cut. The effects of taxing sodas on increasing revenue are of no doubt. The Congressional Budget Office estimated that taxing soda at a rate of 3 cents per 12-ounce serving could generate over $24 billion, from 2009 to 2013, and $50 billion over the 2009 - 2018 period (Congressional Budget Office (CBO), 2008). However, analytical results of tax effects on controlling soft drink consumptions are mixed.

Literature Review

Preponderant empirical studies investigating tax effects the issue using own and cross price elasticity of demand. For example, Andreyeba et al., (2010) identified all published US studies of food price elasticity of demand from 1938 to 2007, and combined their estimates into average estimated price elasticities for 16 major food and beverage groups. They found that soft drink price elasticity of demand ranged from 0.13 to 3.18 in absolute values. On average, a 10% increase in soft drink prices should reduce consumption by 8% to 10%. As a result, they suggest that a 10% tax on soft drinks could lead to an 8% to 10% reduction in purchases of these beverages. Lopez and Fantuzzi (2012) examined US consumer CSD choices using a random coefficient logit model, obtained the own and cross price elasticities, and assessed the effectiveness of a tax through counterfactual experiments. They provide both low own and cross price elasticities and assuming full price transmission, they concluded that taxes on caloric CSDs are not an effective policy to reduce obesity. Liu, Lopez, and Zhu (2013) compared the effectiveness of four policy options to decrease the consumption of CSDs, a one cent per ounce soda tax, a ban on television advertising, limiting calories to 100 per 12 ounce volume, and banning large containers such as the 2 litter bottle. By levying the 1 cent soda tax directly onto the shelf prices and using the own price elasticity of demand, the authors concluded that a one cent per oz soda tax induces a 6.32% decline in the global consumption of CSDs, representing the lowest impact on curbing CSD consumption among the four policy scenarios.

One key assumption of using price elasticity to describe tax effects is that taxes are as salient as prices to consumers. However, it is not the case for many packaged products such as soft drinks. Because sales taxes are not reflected in the price tag and sometimes are not even stated on the receipt, they are not apparent to consumers. Chetty, Looney, and Kroft (2009) examined consumers' behaviors according to the salience degree of sales taxes. Evident from field experiments, they concluded that increases in taxes included in posted prices reduce general consumption more than increases in taxes applied at the register. Because most of the sales taxes are imposed at the registers and are not salient to consumers, their findings imply that the public awareness of soft drink taxes are weak, and the effect of sales taxes on curbing CSD consumptions might be overestimated.

Furthermore, consumers' knowledge on tax status also plays a significant role in determining the effectiveness of taxes on product consumption. Zheng, McLaughlin, and Kaiser (2012) examined the effect of a change in sales or excise tax on food and beverage demand after considering that consumers may have imperfect tax knowledge, are sometimes inattentive to sales tax, may not be informed of a sales tax change, and pay no sales tax on eligible food or beverages if using food stamps. By conducting surveys at grocery levels, the authors found that 22% consumers are not clear about the correct tax status of soft drinks, and claimed that price elasticity of demand is not an appropriate measure to evaluate tax effects on food or beverage.

As a results, failing to consider that sales taxes are not salient and that consumers have imperfect knowledge on taxes, previous studies on obtaining price elasticities of demand may overestimate the effects of taxes on reducing general soft drink consumptions. In this case, tax elasticity of demand could be a more effective measure for explaining the economic incidence of a sales tax than price elasticity of demand.

In the literature of investigating the effectiveness of taxes on food and beverage consumption, very few of previous studies distinguish between excise and sales taxes. The central assumption is that agents optimize fully with respect to a 100% tax pass through rate: a 1-cent tax increase is assumed to result in a 1-cent price increase. However, it is less likely warranted for most of the food and beverage markets, especially for the soft drink market. Empirical industrial organization literature on pass-through of cost changes concludes that pass-through might be imperfect if the industry is concentrated. In this case, firms price strategically and the shelf prices are likely to not fully shift in response of an excise tax change.

For example, Kenkel (2005) examined Alaska alcohol markets and provided empirical evidence that alcohol taxes are not fully passed through to consumer prices. The author provided estimated tax pass through rate for the market, which ranged from 0.87 to 4.19. Lillard and Sfekas (2013) examined cigarette markets for the period of 1995-2007, and found that both state and federal taxes are shifted forward less than proportionally to retail prices. Bonnet and Requillart (2013) simulated the impact of an enacted excise tax on soft drinks in Europe Unions using a structural model, and found that due to strategic pricing, soft drink firms over shift to tax to consumers. The authors further argued that ignoring firms' strategic pricing would lead to mis-estimations of the impact of taxation by between 15% and 40% depending on the producers and the tax implemented.

As a result, previous studies confound tax effects with price effects due to the frequently made assumption of passive pricing in the soft drink industry. The assumptions further eliminates the fundamental difference between excise and sales taxes, and leads to a lack of distinction between the two. However, excise and sales taxes may influence demand differently due to their tax natures, particularly in a market with strategic firm behavior in which consumers are imperfectly informed. Fail to distinguish between excise and sales taxes will bias the estimation of effects of taxation on soft drink consumption.

Data

Market analysts frequently distinguish regular from diet CSDs. Per capita consumption of regular CSDs peaked around 40 gallons in 1998 and declined since then. However, diet CSD consumption kept a relatively flat pattern, with an average annual per capita consumption of 12.9 gallons from the middle 1980s to 2005. Share of diet CSDs started to slightly increase from 2001, which was opposite to regular ones (Beverage Marketing Corporation, 2011). For this study, I focus on the consumption of regular soft drinks, as they consistently kept a much larger market share than diet ones for the past two decades.

The major data employed in this research is ScanTrack market level purchase data obtained from the Nielsen Company. My sample covers 26 months of sales dollars and volumes of regular CSDs from 2010 to 2012. Prices are obtained and adjusted by the consumer price index (CPI). The raw data consists of observations for every 4 weeks and I aggregate them to a 4-week level for consistency. I keep the top 15 regular CSD brands out of the sample in this study accounting for more than 68% of the market[2].

Six designated market areas (DMAs) including Atlanta, Boston, New York, San Francisco, Chicago, and Seattle are used for the analysis. During the sample period, Atlanta and Boston applied no taxes on CSDs. New York and San Francisco imposed no excise taxes but levy sales taxes on CSDs, with a rate of 8.875% and

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[2] These brands are: A&W, Canada Dry, Coca-Cola, Crush, Dr Pepper, Fanta, Monster Mountain Dew, Pepsi, Schweppes, Seven Up, Sierra Mist, Sprite, Sunkist, and Private labels (CTL BR).

9.5%, respectively. Chicago imposed a sales tax at a rate of 9.5% and an excise tax (3%) on retailers selling CSDs. Seattle collected an excise tax from CSD manufacturers at the rate of 2 cents per 12 ounce, and a sales tax of 9.5%[3](Drenkard, Raut, and Duncan, 2012).

Product characteristics that are assumed to influence consumer tastes include per serving size (12 ounces) numerical contents of calories, sodium, sugar and caffeine of regular CSD products. Information on calories, sodium and sugar are collected from the online free nutrition database, MyFitnessPal[4]. I match the characteristics data with sales data and convert variables into their per ounce values.

The market size is defined as the product of monthly per capita consumption of all US CSDs (regular and diet) and population in each DMA, therefore I have 156 markets in total. The market share of the selected 15 brands are calculated by dividing the corresponding sales volumes by market size. Table 1 contains the summary statistics of the selected brands. There are 4 CSD manufacturers included in the analysis, Coca-Cola, PepsiCo, Dr Pepper, Monster Beverage, along with the Private Labels. Among all these regular brands, Monster contains the most sodium and caffeine, has the highest price, but retains the lowest market share. A&W contains the highest level of calories, which is as about as twice of the lowest calories brand, Canada Dry. All the brands share similar level of sugar content, with an average of 42 g/oz. Mean prices and observed shares of the brands are 4.337 cents/oz and 0.63, respectively. Coca-Cola takes the greatest share of 2.38%, and private labels have the second largest of 1.72%.

Prices of various inputs in producing soft drink products are collected for the control of model endogeneity. Detailed explanation of the selection of specific inputs and corresponding identification issues will be given in the Model and

[3] Other source of tax information:
"State Sales Taxes on Regular, Sugar-Sweetened Soda and Snacks", 2011, Bridging the Gap Program, University of Illinois at Chicago. Available at: www.bridgingthegapresearch.org

[4] http://www.myfitnesspal.com/welcome/learn_more

Methods section. I collect prices of crude oil and electricity from the U.S Energy Information Administration (2013). Source of sugar prices is from Economic Research Service, United States Department of Agriculture (2013). Manufacturing wage rates and producer price index (PPI) are from the Bureau of Labor Statistics are also included for the estimation.

Model and Methods

The Demand Model and Salience of Sales Tax

To picture CSD demand, I use a random coefficient consumer discrete choice model following the framework of BLP (Berry et al. 1995; Nevo 2000b). Assume there are t markets, indexed by *t* = 1, …, *T*, and a total of *J* regular CSD products on the market. A consumer can decide not to choose from the considered products. Thus I introduce an outside option that permits substitution between regular CSDs and other beverage products. Define *j* = 1, …, *J* as a regular CSD and *j* = 0 as the outside product in the beverage market. The conditional indirect utility of consumer *i* from purchasing a product *j* in market *t* is given by

$$U_{ijt} = X_{jt}\beta_i + \alpha_i P_{jt} + \gamma_i S_{jt} + \xi_{ji} + \varepsilon_{ijt} \tag{1.1}$$

where X_{jt} is a 1* K vector of observed *k* characteristics of the regular CSD j in market *t*, such as calories, sodium, sugar, and caffeine, it also includes fixed effects of location, firm and seasonality. β_i is a K*1 vector of individual-specific coefficient estimates of consumers' tastes over each product attribute. P_{jt} and S_{jt} represent the shelf price and the value of sales tax imposed on product *j* in market *t*, respectively. ξ_{ji} captures unobserved product characteristics. ε_{ijt} is a mean zero stochastic term distributed i.i.d as a type I extreme value distribution.

The parameter vectors β_i, α_i, and γ_i consist of random coefficients, capturing individual-specific valuations for the product characteristics, prices and tax values. To capture this heterogeneity of consumer preferences, I model the distribution of model parameters, β_i , α_i, and γ_i as multivariate normal distributions

$$\begin{pmatrix} \beta_i \\ \alpha_i \\ \gamma_i \end{pmatrix} = \begin{pmatrix} \beta \\ \alpha \\ \gamma \end{pmatrix} + \sum v_i \quad v_i \sim P_v{}^*(v) \tag{1.2}$$

where $\beta,$ $\alpha,$ and γ measure the mean preference that is common among all consumers, v_i represents the unobserved household characteristics that is assumed to have a standard multivariate normal distribution $P_v{}^*(v)$. $\sum$ is a $(K+1)*(1+K)$ scaling matrix of the random coefficients that need to be estimated, which allows each component of v_i to have a different variance and allows for correlation between these characteristics.

Let $\theta_1 = (\alpha, \beta, \gamma)$ be the vector containing the linear parameters, and $\theta_2 = \sum$ be the nonlinear parameters. Combining equation (1.1) and (1.2), I have the indirect utility expressed as equation (1.3). δ_{jt} refers to as the mean utility, which is common to all consumers. The term μ_{ijt}+ε_{ijt} depicts a mean-zero heteroskedastic deviation from the mean utility.

$$U_{ijt} = \delta_{jt}\left(X_{jt}, P_{jt}, S_{jt}, \xi_{ji}; \theta_1\right) + \mu_{ijt}\left(X_{jt}, P_{jt}, S_{jt}, v_i; \theta_2\right) + \varepsilon_{ijt}$$
$$\delta_{jt} = X_{jt}\beta + \alpha P_{jt} + \gamma S_{jt} + \xi_{ji} \qquad \mu_{ijt} = \left(X_{jt}, P_{jt}, S_{jt}\right) * \sum v_i \tag{1.3}$$

Different from previous studies, effects of a sales tax are separately incorporated into the utility function (1.1) rather than embedded into price values. The intuition behind is that 1) sales taxes as a public policy instrument are exogenous, neither firms nor consumers can determine a sales tax value; and 2) consumers respond to a sales tax based on their knowledge and spontaneous awareness of the tax status. As a result, effects of a sales tax on consumer demand largely depend on the salience of the tax, and can be greatly different from a price effect. Therefore it should be separately evaluated. Additional to the prices effects, α_i, γ_i captures consumers' response to a sales tax considering the tax is not as salient as prices.

Consumer Choice and Market Share

The utility of the outside good consumption is normalized to zero. The indirect utility of choosing the outside good is $U_{i0t} = \varepsilon_{i0t}$. Since ε_{ijt} is defined to have a type I extreme value distribution, we have a closed form solution of the probability of a consumer would purchase a product *j* in market *t*. By integrating over the set of products, the probability can be expressed as

$$Pr_{ijt}\left(\delta_{jt}, \Sigma\right) = \frac{\exp\left(\delta_{jt} + \mu_{jit}(\nu)\right)}{1 + \sum_{m=1}^{J} \exp\left(\delta_{mt} + \mu_{mit}(\nu)\right)} \tag{1.4}$$

Aggregating over consumers, the market share of product *j* in market *t* can be given as follows

$$S_{jt}\left(\delta_{jt}, \Sigma\right) = \int \frac{\exp\left(\delta_{jt} + \mu_{jt}(\nu)\right)}{1 + \sum_{m=1}^{J} \exp\left(\delta_{mt} + \mu_{mt}(\nu)\right)} dP_v(v)$$

$$= \int Pr_{ijt} \, d\Psi(\beta_i, \alpha_i, \gamma_i \,|\theta) \tag{1.5}$$

where Ψ is the joint distribution of consumer characteristics. $\theta(\theta_1, \theta_2)$ is a vector of parameters for this joint distribution, mainly the heterogeneity variance. The integrals in (1.5) can be obtained by Monte Carlo simulation. The simulated integrals through *N* Monte Carlo draws of v are given by

$$S_{jt}\left(\delta_{jt}, \Sigma\right) \approx \frac{1}{N} \sum_{i=1}^{N} Pr_{ijt} d\Psi(\beta_i, \alpha_i, \gamma_i \,|\theta) \tag{1.6}$$

Supply Side and Pass-through of Excise Tax

The profits of firm *f* is given by

$$\pi_f = \sum_{j \in J_f} (p_j - mc_j - e_j) M s_j(p) - C_f \qquad (1.7)$$

where p_j is the shelf price, mc_j is the marginal cost of production which includes cost shifters such as wages, electricity and energy cost, and costs of sugar and other ingredients. mc_j is assumed to be constant over time (BLP 1999, Nevo 2000a). e_j is the value of excise taxes imposed by the government on the product j. M denotes the market size, and C_f is the fixed production cost. $s_j(p)$ is the market share of product *j*, depending on the prices of all the CSD products in the market. Under the Bertand-Nash equilibrium, every firm is choosing prices to maximize total firm profits, and the optimal price of product *j* from firm *f* must satisfy the following first-order conditions

$$s_j(p) - \Omega \times \frac{\partial s_l(p)}{\partial p} \times (p_l - mc_l - e_l) = 0 \qquad (1.8)$$

where Ω denotes the ownership matrix, and the implied marginal costs are

$$mc_j = p_j - \left[\Omega \times \frac{\partial s_l(p)}{\partial p_j}\right]^{-1} \times s_j(p) \qquad (1.9)$$

Using this set of first-order conditions, I can calculate equilibrium prices and obtain excise pass-through rates through counterfactual experiments.

Identification and Estimation

Prices are potentially correlated with unobserved product characteristics or demand shocks. Endogeneity exists in this case, and to control for this issue, I include exogenous instrument variables. Following the literature, I include several sets of instruments into the estimation to control for price endogeneity, as well as to generate moment conditions to identify random coefficients. Instruments that I adopt include 1) cost shifters of producing CSDs, price of sugar, electricity, and manufacturing wage rates (BLP 1999, Nevo 2001); 2) Hausman type instruments, i.e., products' own prices in other markets (Hausman and Tayor, 1981). The intuition behind is that the prices of the same brand in different markets are correlated due to the common production cost, but are uncorrelated with market specific demand shocks; and 3) Chamberlain's optimal instruments (Reynaert and Verboven, 2014).

I estimate the demand model specified in (1.1) using a nonlinear Generalized Methods of Moments (GMM) estimator. Following BLP (1995), I use the Nested Fixed Point Maximum Likelihood Algorithm approach to estimate the model parameters. Let *IV* be the full set of instrumental variables, the moment function is expressed as

$$g(\delta) = E[IV'\xi] = 0 \tag{1.10}$$

Let Φ be the GMM weighting matrix, the estimated parameters can be solved through the following constrained minimization problem

$$\hat{\theta} = \underset{\theta}{argmin}(\xi' IV \Phi IV' \xi) \tag{1.11}$$

Results

Table 1 presents parameter estimates for the demand model. Product attributes that are included in the model contain calories, sodium and sugar. The parameter estimates of the mean utility for sugar and sodium are statistically significant at the

1% level, meaning that on average, sugar and sodium contained in a CSD product create disutility and utility for a consumer, respectively. Because the base of calculating a sales tax value is the shelf price, include the value of a tax as well as the price may generate the problem of multicollinearity. However, decisions of tax rates are made by policy makers which are exogenous to the model. As a result, sales taxes enter the model in the form of tax rates rather than values. Coefficient estimates of price and sales taxes are both significant at the 1% confidence level and create disutility for consumers. As expected, the mean impact of a sales tax on CSD demand is much smaller comparing to that of a price change. This indicates that the effectiveness of imposing a sales tax on reducing CSD consumption is overestimated by using own price elasticity as a measurement. The distribution of the parameters for sodium, prices and sales taxes are significantly associated with consumer heterogeneity, indicating nonlinear distributional effects rather than fixed point estimates. Considering locations may also cause the multicollinearity problem to the taxes, only season and firm fixed effects are added, which are all significant at the 1% level.

Cross- and own- price and tax elasticities are reported in Table 3 and 4, respectively. Both of the tables present a sample of 10 brands, averaging over 6 cities and 26 months in the study sample. The cross-price and -tax elasticities are all positive as expected, but in small magnitudes. This indicates that substitution is restricted to factors such as the consumer's household sizes, tastes, and awareness of health issues, etc. All the own-price elasticities fall into the (-3.18, -0.13) range concluded by Andreyeba et al., (2010). Note that all the own-tax elasticities are also negative, indicating that sales taxes influence the demand in the same direction as prices do, as one would expect.

Our interests are to see whether a sales tax has a smaller impact comparing to a price increase due to its tax nature, and Table 5 lists own- price and tax elasticities together. For every brand in the sample, its tax elasticity of demand is smaller than the price elasticity in the absolute value, indicating that applying a sales tax is less effective on curbing CSD consumption comparing to directly increasing the shelf price. For example, a 1% increase in the price will generate a 1.9% decrease in the demand of Pepsico, while a 1% increase in the sales tax will cause the Pepsico demand to drop 0.84%. Furthermore, magnitude difference of own-price elasticities among brands are minor, while tax elasticities present a relatively larger range. Demand of private labels will only decline by 0.37% due to a 1% sales tax increase, representing a least tax impact among all brands, while the tax has the most severe impact on the national leading brand Coca-Cola at the elasticity value of -1.35%.

In summary, both sales and excise taxes are negatively correlated with soft drink consumption. Given that sales taxes are not salient to consumers, the magnitude of tax elasticity of demand is much smaller than own price elasticity. Therefore by generalizing the tax nature of sales and excise tax policies and employing price elasticity of demand to assess tax effects, previous studies overestimate the ability of such policies to reduce CSD consumption.

Discussion and Further Work

Another important purpose of this study is to compare the effectiveness of sales and excise taxes on reducing CSD consumption. Using the model estimates, counterfactual studies will be further conducted to answer following questions: 1) whether a 10% excise tax will be fully passed to the shelf price (the reason of choosing the rate of 10% is because most of the sales taxes are applies at or around the level of 10%); 2) if the excise tax is not fully passed, what is the average pass-through rate in the CSD industry; and 3) which tax is more effective, the sales tax or the excise tax?

The literature on CSD consumption and tax effects is substantial. In general, most empirical studies use price elasticities to investigate the issue. Considering the salience problem of a sales tax and strategic pricing behaviors in the CSD industry, price elasticity might be a less accurate measurement. Also, fail to distinguish between a sales and an excise tax will further bias the estimation. This study contributes to the literature by separating price and tax elasticities and distinguishing between the two taxes. Implications of this paper help policy makers focus their efforts to adopt the most appropriate policy instrument and to address obesity issues.

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Figure 1 U.S Per Capita Beverage Consumption 1986-2012

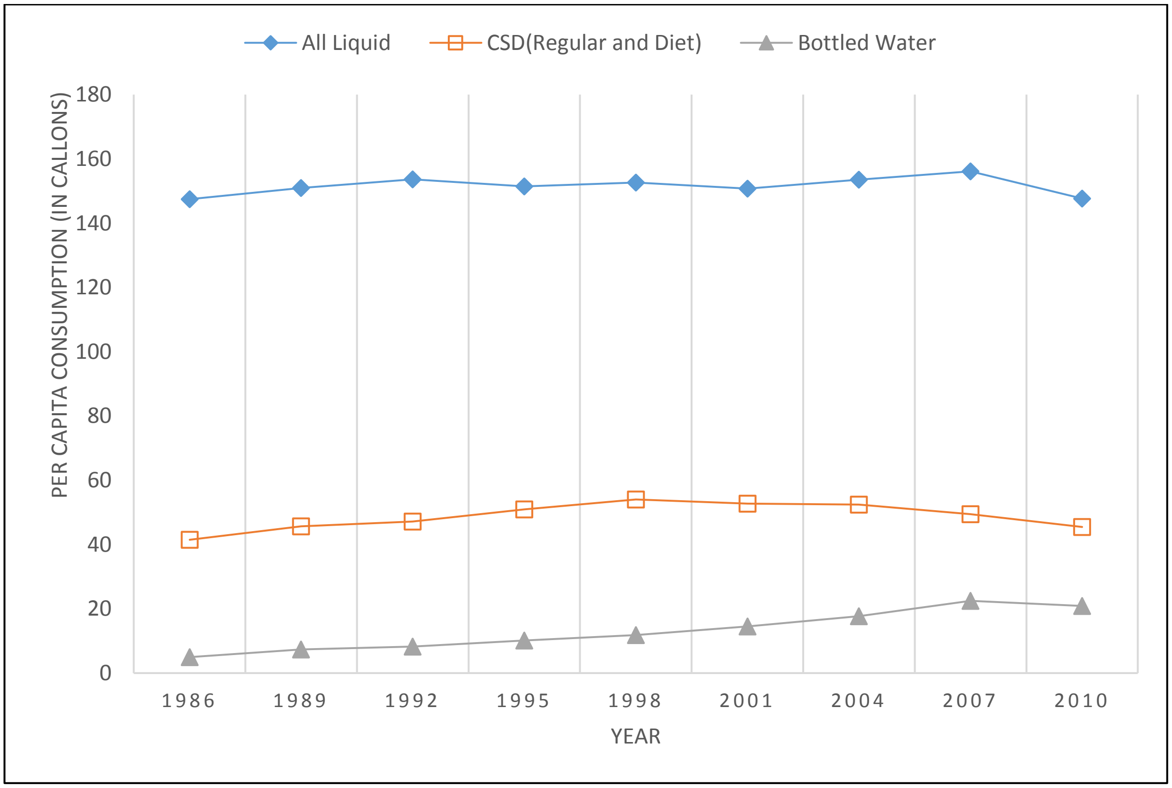

Table 1 Summary Statistics of Top 15 Regular CSD Products

Firm	Brand	Calories (/oz)	Sugar (g/oz)	Sodium (mg/oz)	Caffeine (mg/oz)	CPI Adjusted Price (cents/oz)	Observed Share (%)
Coca -Cola	Coca-Cola	140	39	50	34	3.157	2.38
	Fanta	160	44	55	0	3.563	0.22
	Sprite	144	38	70	0	3.434	0.70
PepsiCo	Mountain Dew	170	46	65	54	3.565	0.56
	Pepsi	150	41	30	38	3.374	1.54
	Sierra Mist	150	39	38	0	3.432	0.20
Dr Pepper	A & W	250	43	78	0	2.989	0.20
	Canada Dry	130	32	50	0	4.418	0.43
	Crush	160	43	70	0	3.934	0.28
	Dr Pepper	150	44	55	41	3.355	0.44
	Schweppes	160	38	68	0	7.550	0.31
	Seven Up	140	38	40	0	5.132	0.30
	Sunkist	190	50	70	41	3.432	0.18
Monster	Monster	163	40	266	120	11.857	0.01
CTL BR	CTL BR	180	48	53	23	1.873	1.72
Mean Value		162	42	71	23	4.338	0.61

Table 2 Parameter Estimates of Demand Model

	Variable	Means	Deviations
Characteristics	Calories	-0.687 (1.033)	-0.171 (0.477)
	Sodium(mg/oz)	0.094** (0.026)	0.031*** (0.003)
	Sugar(g/oz)	-0.783*** (0.014)	-0.008 (0.018)
	Constant	-0.566*** (0.017)	1.065*** (0.183)
Price and Sales Tax	Price (cent/oz)	-3.268*** (0.015)	-1.240*** (0.256)
	Sales Tax (cent/oz)	-0.624*** (0.081)	-0.500*** (0.098)
Fixed Effects	DMA	No	
	Summer	-0.216*** (0.003)	
	Coca-Cola	-0.910*** (0.246)	
	PepsiCo	-1.108*** (0.013)	
	Dr Pepper	-2.230*** (0.108)	
	Monster	-4.814*** (0.062)	

Note: *** p<0.01, **P<0.05, *P<0.1

Table 3 Sample of Estimated Own- and Cross-Price Elasticities

Brands	A&W	Canada Dry	Coca-Cola	Crush	CTL BR	Dr Pepper	Fanta	Monster	Mountain Dew	Pepsi
A&W	**-1.716**	0.002	0.010	0.013	0.002	0.002	0.006	0.002	0.003	0.001
Canada Dry	0.033	**-1.701**	0.011	0.012	0.001	0.004	0.001	0.003	0.002	0.001
Coca-Cola	0.030	0.003	**-1.943**	0.013	0.002	0.004	0.002	0.003	0.002	0.001
Crush	0.030	0.003	0.009	**-1.960**	0.002	0.005	0.002	0.004	0.002	0.001
CTL BR	0.025	0.002	0.009	0.014	**-2.011**	0.004	0.002	0.003	0.002	0.001
Dr Pepper	0.032	0.003	0.007	0.018	0.001	**-1.887**	0.002	0.002	0.002	0.001
Fanta	0.027	0.002	0.008	0.014	0.001	0.006	**-1.674**	0.002	0.002	0.001
Monster	0.025	0.002	0.008	0.014	0.002	0.004	0.001	**-1.861**	0.001	0.001
Mountain Dew	0.018	0.001	0.006	0.010	0.001	0.002	0.001	0.002	**-1.349**	0.000
Pepsi	0.020	0.002	0.004	0.011	0.001	0.002	0.001	0.002	0.001	**-1.479**

Table 4 Sample of Estimated Own- and Cross-Sales Tax Elasticities

Brands	A&W	Canada Dry	Coca-Cola	Crush	CTL BR	Dr Pepper	Fanta	Monster	Mountain Dew	Pepsi
A&W	**-1.348**	0.003	0.017	0.014	0.002	0.005	0.002	0.003	0.005	0.000
Canada Dry	0.042	**-0.945**	0.015	0.011	0.001	0.004	0.001	0.002	0.005	0.000
Coca-Cola	0.055	0.004	**-1.144**	0.013	0.002	0.006	0.001	0.003	0.005	0.000
Crush	0.030	0.002	0.008	**-0.838**	0.001	0.003	0.001	0.003	0.003	0.000
CTL BR	0.031	0.003	0.010	0.010	**-0.881**	0.003	0.002	0.003	0.003	0.000
Dr Pepper	0.043	0.003	0.017	0.013	0.001	**-1.057**	0.002	0.003	0.003	0.000
Fanta	0.029	0.001	0.007	0.009	0.001	0.002	**-0.587**	0.002	0.002	0.000
Monster	0.031	0.002	0.010	0.012	0.001	0.005	0.001	**-0.968**	0.006	0.000
Mountain Dew	0.040	0.003	0.010	0.009	0.001	0.003	0.001	0.004	**-1.073**	0.000
Pepsi	0.010	0.001	0.003	0.005	0.001	0.001	0.001	0.001	0.001	**-0.365**

Table 5 Estimated Own Elasticities, Marginal Costs, and Price Cost Margins (PCM)

Firm	Brand	Price Elasticity	Sales Tax Elasticity	Marginal Cost (cent/oz)	PCM (%)
Coca-Cola	Coca-Cola	-1.716	-1.348	0.973	90.4
	Fanta	-1.701	-0.945	0.576	58.7
PepsiCo	Mountain Dew	-1.943	-1.144	1.256	57.8
	Pepsi	-1.960	-0.838	0.384	45.5
Dr Pepper	A & W	-2.011	-0.881	0.911	88.6
	Canada Dry	-1.887	-1.057	0.806	76.5
	Crush	-1.674	-0.587	0.771	62.1
	Dr Pepper	-1.861	-0.968	1.147	75.9
Monster	Monster	-1.349	-1.073	1.100	82.6
CTL BR	CTL BR	-1.479	-0.365	0.964	77.9