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Arteaga, Julio Cesar and Flores, Daniel and Luna, Edgar

Facultad de Economía, Universidad Autónoma de Nuevo León

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# The effect of a soft-drink tax in Mexico: a time series approach

Julio C. Arteaga  
julio.artegagr@uanl.edu.mx

Daniel Flores  
daniel.florescr@uanl.edu.mx

Edgar Luna  
edgar.lunadmz@uanl.edu.mx

Facultad de Economía, Universidad Autónoma de Nuevo León, Ave. Lázaro Cárdenas 4600 Ote. Frac. Residencial Las Torres, CP, 64930, Monterrey, Nuevo León, México.

## Abstract

We use a time series approach and industry data to estimate the effect on consumption of an excise tax on soft drinks imposed recently in Mexico. The tax caused a price increase of 12.8% and reduced per-capita consumption about 3.8%. This effect is small in comparison to the effects suggested by most studies that have estimated price elasticities using an almost-ideal-demand-system and household survey data.

## 1. Introduction

Unlike most staple food, soft drinks in Mexico are subject to a 16% Value Added Tax (VAT).<sup>1</sup> In addition to the VAT, consumers pay an excise tax of \$1 peso per liter on sugary drinks since the beginning of year 2014. This tax came into effect at the beginning of year 2014 as part of the tax reform proposed by President Peña. Among many other things, the reform included taxes on certain high-calorie foods and sugary drinks. These taxes were justified as a measure to reduce overweight and obesity rather than collecting tax revenue.<sup>2</sup>

Before the introduction of the excise tax, the average price of a liter of soft drink in Mexico was \$7.8 pesos.<sup>3</sup> Therefore, the tax represented 12.8% of the price. As expected, the tax was passed on to consumers. It is relatively easy to establish that this price change was caused by the tax because the average price of soft drinks in real terms remained practically unchanged for several years until the tax was introduced. Moreover, there was a one-to-one transmission of the tax to consumers. Indeed, if we compare the soft drinks

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<sup>1</sup> Taxing food and medicine has been a taboo in Mexico. The current VAT on these products is zero. At the beginning of his term, President Fox proposed a (positive) VAT on food and medicine. However, his proposal was not approved by congress (Tello and Hernandez, 2010).

<sup>2</sup> Cash and Lacanilao (2007) say that this type of intervention –called fat tax– is one of the most common approaches used recently by policy makers to fight obesity.

<sup>3</sup> This figure is calculated with industry soft drink sales and sales volume gathered by INEGI. We took the average implicit price of a liter of soft drinks in the last three months of the year and added the VAT.

price index of the last month of 2013 with the first month of 2014, then we can find that the price of soft drinks increased exactly 12.8%.<sup>4</sup>

It is interesting to look at the effects of the tax on soft drinks in Mexico for several reasons. First, there are proposals to levy large taxes on soft drinks in other countries, including the US. Therefore, the Mexican experience provides some insight into what could happen if these countries approve them. Second, although the US has a large experience with soft drink taxes, most of them have been relatively small in comparison to the Mexican tax.<sup>5</sup> Third, there are few countries in the world in which consumption of soft drinks is as high as it is in the US. Mexico is one of these countries. During the year before the tax came into effect, daily per-capita consumption of soft drinks in Mexico was about 0.44 liters (or 14.8 ounces). Fourth, unlike state soft drink taxes in the US, the Mexican tax was introduced at the same time in the whole nation. Therefore, cross-border shopping is not an issue here.<sup>6</sup>

In this article, we use industry sales time series data to estimate the effect of a one-peso tax on per-capita consumption of soft drinks in Mexico. According to our estimates, the tax reduced per-capita consumption about 3.8%. This figure represents about 0.0167 liters or 7 calories per day. Interestingly, this reduction in consumption is fairly small in comparison to what previous studies suggest.

The rest of the document is organized as follows. Section 2 reviews the related literature briefly. Section 3 explains the data and the econometric model that are used to estimate the effect of the tax. Section 4 discusses estimation results. Section 5 presents the main conclusions.

## **2. Brief review of the literature**

The effectiveness of the tax on soft drinks to reduce obesity depends on a series of events that have been widely discussed –mostly separately– in the economic literature. In particular, the tax can be effective if: (a) it causes a relatively large increase in the price of soft drinks (that is, a large part of the tax is passed on to consumers); (b) consumption of soft drinks is sensitive to its price (in other words, the price elasticity of demand for soft drinks is large); (c) a lower consumption of soft drinks actually reduces individuals' caloric intake (that is, soft drinks calories are not substituted with other calories); and (d) a lower caloric intake reduces overweight and obesity (this requires soft drink calories to represent a relatively large portion of individuals' caloric intake).

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<sup>4</sup> Grogger (2017) finds that the tax was more than fully passed to consumer considering that the average price of a liter of soda was 11.4 pesos. His figure comes from prices used by INEGI to calculate the consumers' price index. However, there is no doubt that the price increased almost 13% after the tax.

<sup>5</sup> According to Cawley (2015), the average state tax on soft drinks in the US is about 4%.

<sup>6</sup> See Tosun and Skidmore (2007) for an example of the effects of cross-border shopping in the US.

Our article studies specifically the effect of the Mexican soft drink tax on consumption. Therefore, this brief review of the literature focuses on the first two issues listed in the previous paragraph. That is, the effect of the tax on the price of the good as well as the effect of the price change (caused by the tax) on consumption. Nevertheless, it is worth mentioning that some recent studies such as Lin et al. (2011) and Fletcher et al. (2014) include more detailed reviews of all the relevant literature.

There is a group of studies such as Lin et al. (2011), Zhen et al. (2011) and Dharmasena and Capps (2012) that evaluate the effects of a hypothetical soft drink tax on the consumption of this good in the US. The standard assumption in this literature is that there is a one-to-one transmission of the tax to consumers.<sup>7</sup> With this idea in mind, the authors use a panel data on households' food and drink purchases in order to estimate an almost-ideal-demand-system. Afterwards, they use direct and cross price elasticity estimates to simulate the effects of a price increase in soft drinks (presumably caused by the tax) on consumption. The price elasticity estimates that they find are between 0.95 and 2.26. These numbers indicate that a 20% tax would reduce consumption of soft drinks between 19 and 45%.

A few articles such as Valero (2006) and Colechero et al. (2015) estimate the price elasticity of demand for soft drinks in Mexico. These studies use data –gathered before the approval of the tax– from the households' incomes and expenditures national survey (ENIGH). It is important to mention that this data base is a cross-section instead of a panel. Nevertheless, the results of Valero (2006) and Colchero et al. (2015) are in line with previous findings. Valero (2006) estimates that own price elasticity of demand for soft drinks in Mexico is 1.4, while Colchero et al. (2015) find it to be slightly above unity (between 1.06 and 1.16). These elasticities suggest that a 12.8% increase in the price of soft drinks –such as the one that took place in Mexico after the tax– would reduce consumption between 13.6 and 17.9%.

In contrast with most of the literature, Fuentes and Zamudio (2014) find relatively small own price elasticity estimates of demand for soft drinks in Mexico. Their estimates are between 0.16 and 0.44. It is important to say that Fuentes and Zamudio (2014) use ENIGH as Valero (2006) and Colchero et al. (2015), as well as similar estimation methods. However, they estimate price elasticities for different groups of soft drink package sizes. In other words, they control for price discrimination practices –volume discounts– that are common in this industry. If their price elasticity estimates are correct, we would expect consumption to fall between 2 and 5.6% as a consequence of the Mexican tax on soft drinks.

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<sup>7</sup> As explained earlier, the Mexican experience corroborates that this is the case. Moreover, Grogger (2017) claims that the Mexican soft drink tax was more than fully passed to consumers.

Interestingly, there are a few recent studies that use the Mexican soft drink tax to estimate its effects on consumption.<sup>8</sup> For instance, Colchero et al. (2016) use a panel data of household purchases covering two years before the tax and one year after the tax. They estimate that –on average– the tax reduced per-capita consumption by 6% during the first year. Moreover, they argue that the effect of the tax increases with time. In particular, they claim that consumption falls 12% by the end of the year. More recently, Colchero et al. (2017) estimate smaller effects for the same tax. That is, they calculated that per-capita consumption of soft drinks decreased 5.5% during the first year and 9.7% during the second year after the tax. It is important to note that these figures are small in comparison to what most price elasticity estimates suggest but slightly larger than what we would expect if Fuentes and Zamudio (2014) elasticity estimates are correct.

### 3. Data and Econometric Model

Unlike most previous studies that use household cross-sections or panel data, we use monthly industry time series data (from January of 2007 to March of 2017) in order to estimate the effect of the Mexican soft drinks tax on consumption.<sup>9</sup> An advantage of this approach is that industry data covers consumption both at-home and away-from-home, while household data only covers the former. Consumption of soft drinks away-from-home is relatively large in Mexico. For instance, daily per-capita soft drinks consumption estimates in Colchero et al. (2017) are below 0.2 liters, while industry data –as we will show in a moment– reveals that this figure is well above 0.35 liters.

It is important to mention that soft drinks industry sales should match consumption very closely. Soft drinks are costly to transport. Therefore, imports and exports are very unusual in this market. Indeed, soft drink companies in Mexico and many other countries around the world distribute their products through a network of bottlers across the country. Hence, consumers by enlarge buy soft drinks that not only are bottled in the country but very likely in their own towns.

The dependent variable in our study is average daily consumption of soft drinks per-capita. We construct this variable by combining soft drinks industry sales data from *Instituto Nacional de Estadística y Geografía* (INEGI) with population data from *Consejo Nacional de Población* (CONAPO). In particular, we use INEGI’s monthly manufacturing industry survey (EMIM) to obtain the amount of soft drink (in liters) sold in the country

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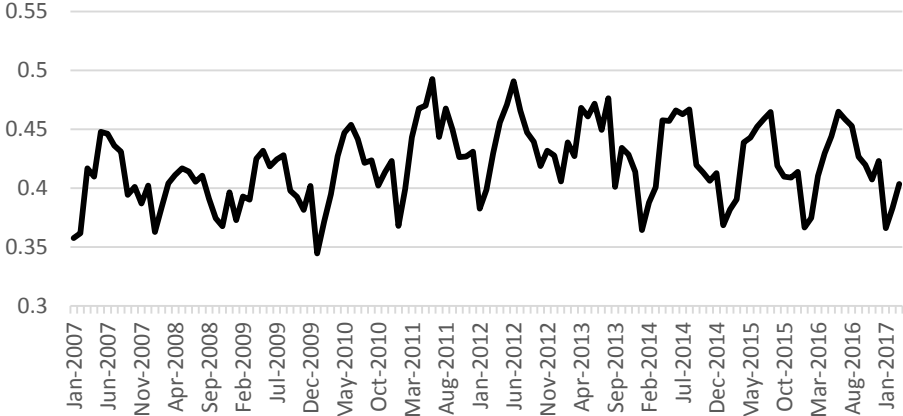
<sup>8</sup> There are some studies in the US such as Fletcher et al. (2010) and Fletcher et al. (2013) that use actual tax changes to evaluate the effects of a soft drink tax.

<sup>9</sup> Blundell et al. (1993) compare micro and aggregate-based demand models. They conclude that micro based models do not outperform aggregate-based models in terms of prediction or estimation of the price elasticity.

each month. This variable is divided by the number of days and the projected population in the corresponding month.<sup>10</sup>

Figure 1 shows monthly averages of daily per-capita soft drinks consumption in Mexico during the last 10 years. Note that during most of the period, daily per-capita consumption of soft drinks in Mexico is well above 0.35 liters (about a 12 ounce can of soda). Furthermore, note that consumption exhibits large changes within the year depending on weather conditions. It typically increases during the summer and decreases during the winter. For any given year, January is the month in which consumption is the lowest. On the other hand, the month in which consumption is the highest may be between May and August depending on the year.

Figure 1. Average daily consumption of soft drinks per capita in Mexico in liters



Given that consumption exhibits large changes within the year as well as some changes across the years, it is extremely difficult to detect the effect of the tax –if any– by simply looking at the data. For instance, the highest per-capita consumption of soft drinks in the series took place in the summer of year 2011. Since then, summer peak consumption of soft drinks has been falling year after year. This reduction in consumption started several years before the introduction of the tax.

Some basic statistics of the monthly averages of daily per-capita soft drinks consumption in years 2013 and 2014 can help us have a first approximation of the effect of the tax. Table 1 shows the mean and standard deviation of daily average per-capita consumption of soft drinks in Mexico during the years immediately before and after the tax. The difference between the two means is 0.0134 liters (about 0.46 ounces). Note that this quantity is about one half of the standard deviation. Note also that this change represents about 3% of mean consumption before the tax.

<sup>10</sup> CONAPO publishes Mexican population projections for years 1990-2010 and 2010-2030. This information can be obtained from the following link: [http://www.conapo.gob.mx/es/CONAPO/Proyecciones\\_Datos](http://www.conapo.gob.mx/es/CONAPO/Proyecciones_Datos). We use this data and assume a constant monthly population growth rate during the year to generate a monthly population projection.

**Table 1. Average of daily consumption before and after the tax**

	Mean		Standard Deviation	
	Liters	Ounces	Liters	Ounces
2013 (Before the tax)	0.4396	14.87	0.026	0.87
2014 (After the tax)	0.4226	14.41	0.035	1.17
Difference	-0.0134	-0.46		

Sources: Elaborated with data from CONAPO and INEGI.

While the simple comparison of average per-capita consumption right before and after the tax is a reasonable approximation of the effect of the tax, it does not take into account the dynamics of the time series. We can obtain a better estimate of the effect of the tax by regressing a soft drinks consumption equation that considers potentials trends and a structural break, as well as season effects.<sup>11</sup>

$$\ln q_t = \beta_0 + \beta_1 trend_t + \beta_2 break_t + \sum_{r=1}^{11} \beta_{r+2} D_s + \delta tax_t + \varepsilon_t.$$

The variables in this equation are defined as follows. The dependent variable,  $\ln q_t$ , is the natural logarithm of average per-capita consumption of soft drinks at month  $t$ . The independent variables include: a deterministic  $trend_t$ , a dummy variable  $break_t$ ,<sup>12</sup> a set of dummy variables (one for each month)  $D_s$ ,<sup>13</sup> a dummy variable  $tax_t$  and an error term  $\varepsilon_t$ . Note that coefficient  $\delta$  captures the effect of the tax on soft drinks consumption. Finally, it is worth highlighting that by using the dummy variable  $tax_t$ —which is clearly exogenous—instead of the price index of soft drinks, we can solve the latent problem of endogeneity between quantity and price in this market.

#### 4. Results

We estimated several versions of the empirical model trying to take into account that the data suggests the presence of a trend, a structural break and a change in trend after the break. The first version includes a trend, a structural break and an interaction between the trend and the structural break. The interaction term attempts to capture a potential change in the trend after the break. The second version excludes the interaction term. The third version excludes the trend but includes the interaction term. The last version excludes the trend and the interaction term.

<sup>11</sup> Even though the Augmented Dickey Fuller (ADF, 1981) unit root test suggests that this variable is non stationary, we include this variable in levels, and not in first differences, in our equation. The reason is that Phillips-Perron (1988) tests suggest the variable is stationary. Additionally, and due to the presences of structural breaks, we also estimate Zivot and Andrews (1992) and Lee and Strazicich (2003,2004) unit root tests under the presence of parameter instability. Both tests conclude that the per-capita consumption of soft drink series is stationary.

<sup>12</sup> We estimate various regression models changing the date of the structural break. We set it on November 2010 as it has the highest value of the t-statistics of the parameter associated with the structural break.

<sup>13</sup> We exclude the month of December. Thus monthly dummies reflect changes in consumption with respect to this month.

Table 2 shows the main results of estimating directly the impact of a soft drink tax on per-capita consumption of these goods in Mexico. It is important to mention that we corrected these estimates for heteroscedasticity.<sup>14</sup> Thus, we include heteroscedasticity and consistent standard errors in parenthesis. The results confirm that there was a structural break at the end of year 2010. Per-capita consumption increased about 8% after the break. Although the coefficients associated with the trend or its interaction with the structural break are not statistically different from zero, we report the results of the different versions of the empirical model. There seems to be a very small positive trend in consumption before the break and a similarly small but negative one afterwards.

**Table 2. Estimated impact of a tax on soft drink consumption in Mexico**

Variable	(1)	(2)	(3)	(4)
Intercept	-0.93187*** (0.01317)	-0.92865*** (0.01066)	-0.92714*** (0.01066)	-0.92725*** (0.00731)
Trend	0.00021 (0.00040)	0.00006 (0.00027)		
Break	0.09183*** (0.02226)	0.08020*** (0.01320)	0.08731*** (0.02089)	0.08265*** (0.00854)
Trend*Break	-0.00028 (0.00048)		-0.00007 (0.00032)	
Tax	-0.03558** (0.01622)	-0.04051*** (0.01404)	-0.03545** (0.01611)	-0.03825*** (0.00718)
R <sup>2</sup>	0.87145	0.87098	0.87096	0.87090
R <sup>2</sup> adj	0.85343	0.85425	0.85424	0.85550
AIC	-4.09841	-4.11101	-4.11090	-4.12663
Schwarz	-3.73260	-3.76806	-3.76795	-3.80655
Observations	123	123	123	123

Notes: Heteroscedasticity and consistent standard errors in parenthesis.

\*\*\* Significant at 1%. \*\* Significant at 5%. \* Significant at 10%. The estimated equation includes a set of 11 seasonal dummy variables.

It is easy to observe that the inclusion of a trend affects the magnitude of the estimated effect of the tax on per-capita consumption of soft drinks. If we only include a linear trend in the regression, as in column (2), we find that the tax reduces per-capita consumption about 4%. However, if we include an interaction term that takes into account for a change in the trend, as in column (3), then we find that the effect of the tax is about 3.5%. Finally, if we use standard criteria to select the model, then it is better to exclude both the trend and the interaction term as in column (4). This suggests that Colchero et al. (2016) conclusion about the effect of the tax on consumption increasing with time may not be correct.

<sup>14</sup> We borrow the procedure from Newey and West (1987).



Once we control for seasonal dynamics of consumption and the existence of a structural break in the series, it is clear that the tax imposed on soft drinks in Mexico did reduce consumption. More precisely, the tax reduced per-capita consumption of soft drinks 3.8%.<sup>15</sup> This figure is a bit larger than the first approximation of 3% obtained by comparing mean per-capita consumption right before and after the tax. However, the effect of the tax is about a quarter of the size suggested by price elasticity estimates obtained in previous studies such as Valero (2006) or Colchero et al. (2015), and about two thirds the size of direct estimates of the effect of the tax in Colchero et al. (2016) and Colchero et al. (2017). Interestingly, this estimate is in line with price elasticity estimates obtained by Fuentes and Zamudio (2014).

## 5. Conclusions

We estimate the effect of the relatively large excise tax imposed by the Mexican government on the consumption of soft drinks. Unlike most previous studies in the literature, we use a time series approach and industry data. We conclude that the tax caused a price increase of 12.8% and reduced per-capita consumption about 3.8%. This effect is fairly small in comparison to the effects that are suggested by most studies that estimate price elasticities using an almost-ideal-demand-system and household survey data. A notable exception is Fuentes and Zamudio (2014). They find similar results by controlling for package-size price discrimination.

We tested several econometric models to control for trends and a structural break in the soft drinks consumption time series. The effect of the tax on per-capita consumption is sensible to the inclusion of trends in the regressions. Standard criteria suggest including a structural break but not the trends. In light of these results, it is hard to argue that the effect of the tax increases with time as suggested by previous studies.

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<sup>15</sup> A 95% confidence interval around the tax coefficient,  $\delta$ , indicates that per-capita consumption decreased between 2.4 and 5.25%.

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