Chapter 12

Evaluating the 2014 Sugar-Sweetened Beverage Tax in Chile: Observational Evidence from Urban Areas

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Abstract

An already large and growing number of countries — both rich and poor — are facing an enormous challenge to curb rising rates of obesity and diet-related ill-health, much of which affects lower socio-economic groups. Fiscal policy has the potential to influence consumption patterns toward healthier options (and raise government revenue for welfare-enhancing purposes), thereby contributing to the prevention of chronic diseases and to the reduction of the associated economic costs. Yet, there is a scarcity of empirical evaluations of diet-related fiscal interventions, and it is still uncertain whether these can be effective in improving population diet and health in a “real-world” context. Chile is one of the very few countries that have thus far implemented an explicit fiscal policy to improve healthier diets. In this chapter, we describe and discuss the results of our impact evaluation of the tax policy (Nakamura *et al.*, 2018). Results were mixed, showing population average results that consistently indicated a decrease in the monthly purchased volume of the higher taxed sugar sweetened beverages (SSBs) (21.6% for the statistically preferred model), but also one that varied considerably in magnitude across different models, thereby reducing the confidence in

this overall estimate. The reduction in soft drink-purchasing was most robustly evident amongst higher socio-economic groups and higher pre-tax purchasers of sugary soft drinks. There was no systematic, robust pattern in the estimates by households' obesity status.

This suggests that the policy may have been partially effective, though not necessarily in ways that are likely to reduce socio-economic inequalities in diet-related health. A longer term evaluation, ideally including an assessment of the consumption and health impacts, should be conducted in future research.

1. Introduction

Very few countries have thus far implemented an explicit fiscal policy to improve healthier diets. In October 2014, Chile implemented a tax modification on sugar sweetened beverages (SSBs) called the *Impuesto Adicional a las Bebidas Analcohólicas* (IABA), adopting a thus far unique design by increasing the tax on soft drinks above 6.25 g of added sugar per 100 ml and decreasing the tax for those below this threshold. In a recently published article (Nakamura *et al.*, 2018), we have evaluated the SSB tax, using a quasi-experimental design applied to detailed household-level grocery-purchasing data from 2011 to 2015. Here, we summarize the main approach, findings and implications of this study. Detailed results and supplementary material are available in the original paper.

While the research focused on Chile, it is of global relevance, across low-, middle- and high-income countries, as reducing the burden of non-communicable diseases (NCDs) has been widely recognized as an overriding global health priority and a necessary condition for sustainable development (WHO, 2014). Diet-related health problems account for a large and growing share of the NCD burden worldwide, causing substantial human suffering and adverse economic consequences (Bloom *et al.*, 2011; Suhrcke *et al.*, 2006). The situation is of particular concern in Latin America and the Caribbean — a region that has been predicted to reach the highest levels of overweight and obesity worldwide by 2030 (Kelly *et al.*, 2008). Chile appears to be in a particularly challenging situation, as, for instance, illustrated by the fact that, in 2014, the country topped the

worldwide ranking of per capita daily SSB consumption, while also recording the highest growth rate of SSB consumption in the 2009–2014 period (Popkin and Hawkes, 2016).

Fiscal policies have the potential to promote healthier consumption patterns, thereby contributing to the prevention of chronic diseases and their associated economic costs. They may also lead to increased government revenue that could in turn be used for welfare-enhancing purposes. Yet, we do not really know with confidence whether fiscal policy really *does* have the intended effects, as only preciously few countries have thus far introduced such policies. What little such evidence exists — from Mexico (Colchero *et al.*, 2016), Denmark (Smed *et al.*, 2016), Hungary (Bíró, 2015) and Berkeley, California (Silver *et al.*, 2017) — does indicate some early success though.

Since 1960, Chile has had a tax on non-alcoholic drinks called the IABA, or “additional tax on soft drinks” (Escalona, 2014) — an *ad valorem* tax that had been fixed at 13% since 1976. In March 2014, the Parliament announced a modification of IABA. At that point, the plan was to focus on a tax increase (by 5%) for all soft drinks containing any added sugar. At a later stage, but still ahead of the October 2014 implementation, it was decided to reduce the tax rate by 3% for low sugar items. In October 2014, Chile implemented the tax modification. The tax affects any non-alcoholic beverages, or soft drinks, to which colourants, flavorings or sweeteners have been added. For beverages above an added sugar concentration of at least 6.25 g per 100 ml, the tax was increased from 13% to 18%, while for those below this threshold the tax was decreased from 13% to 10%, creating effectively an 8% tax difference between these beverage groups. Measured against the WHO recommendation of implementing an at least 20% tax incentive, this may be considered a comparatively small incentive, even if not much smaller than other actual tax rates (e.g. in Berkeley or Mexico) (Colchero *et al.*, 2015).

For other beverages without flavor, sweeteners or colourants (e.g. plain mineral water) there was no tax prior to the reform and no additional taxation was introduced. These tax rates were applied in addition to the existing value-added tax (VAT) of 19%, and no other major policies were implemented around the same time that would influence the purchasing and consumption of soft drinks.

Apart from a slightly lower tax incentive, there are other ways in which the nature of the Chilean tax differs from those implemented elsewhere. For example, in Berkeley and Mexico, the size of the tax amount increases linearly with the volume of the relevant sugary drink (as defined in the policy). The Chilean tax, on the other hand, set a threshold of sugar content and applied either a tax rate increase or decrease to products above or below the threshold. The simultaneous tax increase and tax decrease makes Chile a unique case.

Our research set out to examine the impact of the IABA tax on: (1) the volume of soft drinks purchased and the amount of sugar from soft drinks purchased — both at population level and across different subgroups, (2) on the price of soft drinks and (3) on the shopping patterns of consumers, including the frequency of purchases of soft drinks and the use of price promotions. The full account of the results is available in Nakamura *et al.* (2018). Here, we focus on (1) and (2).

We used detailed household-level food purchasing data collected by a leading commercial research company (Kantar WorldPanel) for the period from January 2011 to December 2015, drawing on raw data from 2,836 households living in cities (and representative of the urban population of Chile). The data include detailed transaction records of the take-home purchases of products in select categories, focusing on the category of non-alcoholic beverages (excluding coffee, tea and dairy products). The data also include information on relevant household characteristics (i.e. socio-economic status, region of residence and (self-reported) BMI of all household members).

We complemented the Kantar WorldPanel data with relevant nutritional information on sugar content for all products that account for the top 90% of sales of all soft drinks in the Kantar WorldPanel data.

All soft drink products were coded into the following three categories based on the sugar content threshold set out in the IABA policy: (1) non-taxed products (non-sugary, non-flavored, non-colored products), (2) low-taxed products (containing equal or less than 6.25 g of sugar per 100 ml) and (3) high-taxed products (containing more than 6.25 g of sugar per 100 ml). We calculated the monthly volume of the purchased items for these three categories and hereafter refer to them as: “no-tax”, “low-tax” and “high-tax”.

We constructed a monthly, household-level panel dataset to analyze the impact of the IABA policy on the volume of soft drinks purchased. Finally, we also linked the Kantar WorldPanel data with information for regional unemployment and temperature. For unemployment, we used the database provided by the Chilean National Institute of Statistics (Encuesta Nacional de Empleo, 2017); and for temperature, data were obtained from the Center for Climate Research and Resiliency (Datos de Temperaturas Medias, 2017).

2. Methods

We employed a quasi-experimental approach to evaluate the impact of the tax policy. Since the tax policy was implemented nationwide at a single point in time, the entire Chilean population was exposed to the policy and there are no direct comparison groups for the evaluation within Chile. Our empirical approach therefore relies on the time series variations before and after the tax implementation in October 2014.

We used a fixed-effects regression approach (Aguilar *et al.*, 2016), the key assumption of this approach being that, after controlling for households' (time-invariant) unobserved characteristics and the general time trend and seasonality of the outcome variables, any remaining changes in the purchasing of soft drinks in the post-tax period will be attributable to the tax. If there are other factors that are time-varying and affect the outcome variables that are unaccounted for, then the estimated impacts will be biased. For details of the empirical approach, we again refer to Nakamura *et al.* (2018). We estimated the following linear model with household fixed effects:

$$\log Y_{it} = \beta_i + \tau \text{Post} + x_{it} \phi + f(t) + \delta_{\text{month}} + \varepsilon_{it}, \quad (1)$$

where $\log Y_{it}$ is the log of per capita volume of items purchased by household i at period t . If a panel household did not show any record of purchasing of soft drinks for a given month, the outcome variable for the household was imputed as zero. The household fixed effect is represented by β_i , which captures household time-invariant unobservable characteristics that may affect purchasing of soft drinks. "Post" is an indicator variable taking a value of 1 if the purchase is made on or after 1 October 2014, and

0 otherwise. The vector x_{it} includes the temperature and unemployment rate for a household's region of residence. Temperature controls for the variation of demand for soft drinks due to climate, whereas the unemployment rate controls for the variation of macroeconomic conditions. The term $f(t)$ is a function to control for a general time trend. We used a flexible approach to polynomial modelling, and the Akaike Information Criterion (AIC) was employed to select the order of the polynomial with the best fit. In this study, we selected a polynomial of order 4, i.e. $f(t) = \alpha_1 t + \alpha_2 t^2 + \alpha_3 t^3 + \alpha_4 t^4$, where α_1 , α_2 , α_3 and α_4 are parameters, and t is centered at October 2014, when the policy was implemented, taking a value of zero. The term δ_{month} represents the month of the year effects, which captures seasonality. Finally, ε_{it} is the idiosyncratic error term. The within-household impact of the tax policy is represented by the parameter τ .

To explore the sensitivity of the results to other modelling approaches, we complemented the above fixed effects regression approach with a difference-in-difference (DiD) approach. This approach uses previous time periods of the treated population as a comparison group and thus diverges from a standard DiD approach that uses two distinct groups. A similar methodology has been employed in a previous evaluation of the impact of a SSB tax in Mexico (Colchero *et al.*, 2016).

3. Results

3.1. Volume of soft drinks purchased

Based on visual inspection of the unadjusted trends in the volume of the relevant soft drink categories before and after the tax implementation (see Nakamura *et al.*, 2018, Figure 1), it is hard to detect a clear overall time trend based on pure visual inspection alone (except the no-tax soft drinks, which show a trend increase). Hence, the need for more fine-grained regression analysis (see Table 1 for the results of the main regression analyses).

Based on the principle of including the time polynomial that minimizes the AIC, the main results included up to a fourth order time polynomial. The results indicate a barely significant decrease in the

Table 1. Results from fixed-effects volume regression model (outcome in log ml).

		SES		
	All	Low	Middle	High
All soft drinks				
Point estimate	−0.060*	−0.043	−0.067	−0.057
Standard error	0.024	0.045	0.041	0.039
Proportionate change	−5.8%*	−4.2%	−6.5%	−5.5%
Pre-tax mean outcome (ml)	7341.40	6567.39	7217.27	8100.41
High tax soft drink				
Point estimate	−0.244***	−0.129	−0.179*	−0.376***
Standard error	0.044	0.073	0.076	0.078
Proportionate change	−21.6%***	−12.1%	−16.4%*	−31.3%***
Pre-tax mean outcome (ml)	3544.84	3524.01	3715.24	3427.45
Low tax soft drink				
Point estimate	0.030	−0.188	0.200	0.073
Standard error	0.062	0.114	0.119	0.094
Proportionate change	3.0%	−17.1%	22.1%	7.6%
Pre-tax mean outcome (ml)	2627.91	2059.60	2422.93	3275.52
No tax soft drink				
Point estimate	−0.105	−0.068	0.083	−0.270**
Standard error	0.054	0.088	0.102	0.092
Proportionate change	−10.0%	−6.6%	8.7%	−23.7%**
Pre-tax mean outcome (ml)	337.77	180.59	286.84	512.31
Sugar				
Point estimate	−0.164***	−0.093	−0.145**	−0.225***
Standard error	0.029	0.05	0.051	0.049
Proportionate change	−15.1%***	−8.9%	−13.5%**	−20.1%***
Pre-tax mean outcome (ml)	368.85	443.51	382.14	366.94
Number of households	2836	1120	963	1138
Number of observations	113,044	36,443	34,010	42,591

Notes: The number of households in each SES group does not add to the total households due to movement between groups. Proportionate change = $\exp(\text{point estimate}) - 1$. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

volume of all soft drinks purchased, but a highly significant decrease on the monthly purchased volume of high-tax soft drinks by 21.6% (i.e. the implied proportionate effect, with the point estimate: -0.244 and standard error: 0.044). This corresponds to a reduction of 766 ml per person per month for an average household (the mean of pre-tax volume is 3,544.8 ml per person per month). The change in purchasing is also reflected in the significant 15.1% decrease in the amount of sugar purchased via soft drinks (point estimate: -0.164 and standard error: 0.029). By contrast, we detected no significant change in either the volume of low-tax items or in the volume of no-tax items purchased. The alternative DiD regression approach largely confirms the results from our preferred fixed-effects approach (see Supplementary Material in Nakamura *et al.*, 2018). In an assessment of the announcement of the tax, we found no significant changes in all, high-tax, no-tax and sugar-purchasing, but we did see a decline in purchasing of low-tax soft drinks (see Nakamura *et al.*, 2018).

For both high-tax soft drinks and the amount of sugar purchased, the overall change in volume appears to be driven by a decrease in the purchasing among the middle and high SES groups, and in the high pre-tax purchasers, which saw a significant reduction in the volume of high-tax soft drinks. For the amount of sugar purchased, the reduction magnitudes were 13.5% for the middle SES group, 20.1% for the high SES group and 23.6% for the high pre-tax purchasers, respectively. This result was robust to the different measures of SES mentioned above (see Supplementary Material in Nakamura *et al.*, 2018).

We further disaggregated the main analysis by splitting the sample into risk factor groups, according to either the mean BMI of adults in the households or the level of per capita purchasing of high-tax soft drinks before the tax. The reduction in purchasing of high-tax items is statistically significant in all BMI groups, and there was no systematic patterning in the magnitude of the effect across groups. For groups categorized according to their pre-tax purchasing volume of high-tax soft drinks, there was a significant reduction of similar size in the middle and highest groups and no statistically significant impact among those in the lowest group.

Further results explored the sensitivity of the point estimates to different choices of functional form of the time trend. All the models with the full sample indicated a reduction in the volume of high-tax soft drinks

and the amount of sugar purchased, but the reduction was only statistically significant using higher order (fourth and fifth) polynomials, as well as a linear time trend. By SES subgroup, for the high-tax soft drinks, all models showed a significant volume decrease in the high SES subgroup and in the high pre-tax purchasers. In the low pre-tax volume purchasers, all the model specifications indicated a non-significant change for the high-tax soft drinks and the amount of sugar purchased. For the other subgroups, in both the volume of high-tax soft drinks purchased and the volume of sugar purchased, a significant decrease was found in some models, while no significant change was observed in other model specifications. For low-tax soft drinks, the full sample models indicated a non-significant change or a significant increase of up to 14.6% in the purchased volume.

Going beyond the analysis of the volume of soft drinks purchased, we also sought to understand some of the potential mechanisms behind the observed changes. In particular, we examined changes in price (not reported here) and in certain *shopping patterns*. We examined the association between the tax implementation and the number of days per month involving purchases of any soft drinks, i.e. the frequency of shopping trips. The frequency of shopping trips that included high-tax soft drinks decreased by 7.8%, and these changes are visible in all SES groups, though they are more significant and larger in the middle and high SES groups. The change in the frequency of shopping trips involving low-tax soft drinks was only significant for the high SES group, with a 5.0% reduction.

Furthermore, we explored whether one way for consumers to “cope” with the tax increase was to revert increasingly to the purchase of price-promoted items. Such behavior seemed to unfold both in relation to high-tax and low-tax soft drinks. We found a less than 1% increase in the use of price promotions, which appears to be driven by the high SES group for high-tax items.

4. Discussion

Evaluating the SSB tax policy in Chile, we find that despite the tax incentive being comparatively small, there are signs that purchasing of

SSBs with higher sugar content has been reduced among the high socio-economic groups of the population. The overall, population-level effect, however, is much less clear.

The results suggest that the Chilean tax policy may have been partially effective, though not necessarily in ways that are likely to reduce socio-economic inequalities in diet-related health. Longer term evaluations are needed to analyze the policy effect on purchasing of SSBs in the long run as well as to evaluate the impact on health outcomes. The evaluation did not involve a randomized design, hence the degree of truly causal interpretation of the results will be limited.

While the reduction in purchasing of soft drinks seen in Table 1 is fairly widespread across SES groups, it is of note that in terms of the volume of high-tax items purchased, the magnitude of reduction was larger for the high SES group than for the middle SES group and statistically insignificant for the low SES group. This may be surprising to those that expect the response to be greatest among those with the tightest budget constraints, i.e. those among the lower SES group. On the other hand, theoretical considerations also predict that the higher and middle SES groups could be better placed either to make cost-minimizing purchasing decisions, and/or to better absorb and act upon the information conveyed by the tax change (i.e. that certain beverages are deemed unhealthy) (Cutler and Lleras-Muney, 2010). While many price elasticity studies, including one in Chile, show that individuals or households at lower incomes are more elastic than those at higher incomes (Green *et al.*, 2013), other studies — especially some that use randomized designs — reject the commonly expected pattern in favor of a more even responsiveness across socio-economic groups (Blakely *et al.*, 2011; Nederkoorn *et al.*, 2011).

Disaggregating the analyses by the obesity status of the household, we found that all groups responded to the tax by cutting down their purchasing of high-tax soft drinks. When disaggregated by volume of high-tax soft drinks purchased in the pre-tax periods, all but the lowest category of high-tax soft drink purchasers significantly reduced the volume of high-tax items purchased. As is shown in Table 1, the baseline level of high-tax soft drink volume purchased was similar between the high and low SES groups, and within the group of high-tax soft drink purchasers, there was considerable representation of households from all SES categories. Disaggregating the

results further by splitting the low-, medium- and high-volume pre-tax purchasers of soft drinks into low, medium and high SES groups, it was revealed that what may be driving the responsiveness within the high-volume purchasers was the responsiveness of the high SES groups (see Supplementary Material in Nakamura *et al.*, 2018). This is consistent with the greater overall change after the tax among the high SES group. However, again there is some degree of sensitivity of these results to the assumptions about the functional form of the time trend.

For the first time in a study evaluating SSB taxation that we are aware of, this work examined other behavioral responses. First, we showed that households decreased the frequency of shopping trips that included high-tax soft drinks and, perhaps as a way of coping with the tax, households modestly increased the use of price promotions.

Finally, the SSB tax was only a minor part of a major tax reform, thus having limited public visibility, and those who have better access to information such as those in higher SES groups, may have been aware of the SSB tax and reacted to it by reducing purchases upon implementation. We explored time series data of internet searches for soft drink- and tax policy-related themes, as a measure of public interest and information-seeking behavior, as retrieved from Google Trends. A higher frequency of internet searches for the related keywords (though subtle) was observed immediately after the policy announcement and implementation. It may therefore be possible — though difficult to test formally — that access to media and information sources, which tend to be more frequently used by the higher SES groups, might partially explain the differences in purchasing of SSBs across SES groups after the tax implementation.

4.1. Implications for future research

Future research would benefit in particular from

- (a) increasing the sample size in the data used,
- (b) analyzing the actual interrelationship between beverage-intake responses and food responses, and
- (c) from examining the impact on consumption (rather than merely purchasing) and health outcomes.

As for (a), due to the relatively limited variations of purchasing from the less than 3,000 households, the within-household estimates of the changes in soft drink-purchasing for the full sample and certain sub-groups could be subject to a degree of uncertainty (and larger standard errors), depending on the functional forms assumed for the time trend in the regression models. Further data collection would likely reduce the uncertainty and increase the precision of the estimates.

As for (b), in this study, we were not able to examine the extent to which the tax policy was associated with the purchased amount of the *overall* sugar contained in all foods and beverages. For instance, it could be the case that those who reduced sugar from soft drinks also increased sugar from confectionaries. However, we did not have information about the sugar content of food products. Future research should explicitly consider the nutrient information of food items as well as of soft drinks, and examine the role of the SSB tax in overall sugar intake from beverages and foods. SSB intake accounts for about one-quarter of the total sugar consumed by the Chilean population (Cediel *et al.*, 2017), implying that a more broad-based sugar tax (also covering added sugar in solid foods) or even a tax on energy-dense and ultra-processed foods more generally, may be more effective in improving diet-related health outcomes. In this context, modelling the anticipated health impacts of different tax strategies in Chile would be a relevant future direction for research.

In terms of (c), the real interest of such research should ultimately be in assessing actual beverage (and food) consumption effects, as well as the impact on health outcomes (or relevant risk factors).

4.2. *Implications for policy*

Previous studies focused on evaluating the impact of the excise tax on purchases and found some significant short-term reductions (Colchero *et al.*, 2016; Silver *et al.*, 2017). Our study evaluated an *ad valorem* tax and also found some signs of a significant reduction in purchases. This might imply that the nature of the tax — specific rate tax or *ad valorem* tax — would not critically affect the effectiveness of the tax policy. However, in judging the full “success” of the tax policy and in considering future

potential improvements, it needs to be borne in mind what the ultimate purpose of a corrective tax should be, from an economic perspective, to help increase the price of SSBs, so as to align their full “social costs”, which include costs on society, economy, health and environment, with the costs that are perceived by the individual. Such social costs could entail the costs of future collectively funded extra health care costs to treat diet-related diseases or the future health problems not anticipated by the individual consumer. With this in mind, it is hard to argue against the notion that the higher the added sugar content in a given beverage, the higher the social costs associated with the consumption of this beverage will be, and hence the higher the taxed amount should be. In light of the current threshold nature of the Chilean SSB tax, those that consume SSBs with particularly large amounts of added sugar (i.e. well above 6.25 g/100 ml) are not discouraged more than those who consume SSBs just above the threshold. Similarly, those who consume SSBs just below the threshold are encouraged to increase consumption. Although we did find that the amount of added sugar from soft drinks purchased did decrease overall, it is still far from clear that this tax design is best suited to maximize the population’s health and social welfare.

The robust sub-group results for the high SES groups suggest that the policy may have been partially effective, though not necessarily likely to reduce socio-economic inequalities in diet-related health, given that the higher SES groups cut down on sugary drinks-purchasing and the lower SES groups do not. This could also imply that the financial burden of the tax is predominantly carried by the latter, increasing the chances that the policy will have regressive financial impacts. Ultimately, policymakers will need to decide whether the expected gains in diet-related health for the higher SES groups would compensate for the potentially increased inequities in diet-related population health.

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