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Designing a food tax to impact food-related non-communicable diseases: the case of Chile

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Abstract

The global shift towards diets high in sugar-sweetened beverages (SSBs) and energy dense ultra-processed foods is linked to higher prevalence of obesity, diabetes and most other noncommunicable diseases (NCDs), causing significant health costs. Chile has the highest SSB consumption in the world, very high junk food intake and very rapid increases in these poor components of the diet plus obesity prevalence. This study's purpose is to compare the effect of different tax schemes for SSBs and ultra-processed foods on nutrient availability, utilizing price-elasticities, which are estimated from a Quadratic Almost Ideal Demand System model, using the 2011–2012 Income and Expenditure survey. We take into account the high proportion of households not purchasing various food and beverage groups (censored nature of data). The food groups considered were: sweets and desserts; salty snacks and chips; meat products and fats; fruits, vegetables and seafood; cereals and cereal products; SSB ready-to-drink; SSB from concentrate; plain water, coffee and tea; and milk, which together represent 90% of food expenditures. The simulated taxes were: (1) 40% price tax on SSBs(22% above the current tax level); (2) a 5 cents per gram of sugar tax on products with added sugar; and (3) 30% price tax on all foods(27% above current tax levels) and beverages (12% above the current tax level) exceeding thresholds on sodium, saturated fat, and added sugar and for which marketing is restricted (based on a Chilean law, effective June 16 2016). Unhealthy foods are price-elastic (−1.99 for salty snacks and chips, −1.06 for SSBs ready-to-drink, and −1.27 for SSBs from concentrate), meaning that the change in consumption is proportionally larger with respect to a change in price. Results are robust to different model specification, and consistent among different socioeconomic sub-populations. Overall, the tax on marketing controlled foods and beverages is associated with the largest reduction in household purchases of sodium, added sugar, saturated fat and calorie purchases. Chile is unique in currently having instituted a small current SSB tax as well as marketing controls and front-of-package labeling of unhealthy foods and beverages. The design of a larger, more comprehensive tax to enhance the overall effect of these policies on healthier diets is a next critical step. This study shows that a large tax on the same foods and beverages already delineated as unhealthy by the marketing controls and front-of-pack labeling should prove to be more effective for promoting a healthier diet.

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Keywords

Price elasticity; food tax options; Junk food tax; SSB tax; nutrient tradeoffs; almost ideal demand system

1. Introduction

Across the globe obesity has increased rapidly, and is linked with many non-communicable diseases (NCDs), imposing significant direct and indirect costs on both individuals and societies (Jaacks, Slining, & Popkin, 2015; Kwan et al., 2016; Malik, Willett, & Hu, 2013; Murray et al., 2012; Withrow & Alter, 2011). Chile is one of the countries with the most rapid increase in income and processed food supply and now ranks as the Latin-American country with the second highest adult obesity prevalence, after Mexico (OECD, 2014). According to the Chilean Ministry of Health estimates, overweight and obesity reached 64.5% among men and 64.3% in women in 2010 (Ministerio de Salud, 2011). Among 6 year old children, obesity prevalence was 25.2% in 2014 (JUNAEB, 2014).

While exact evidence on the role of sugar sweetened beverages (SSBs) and energy dense ultra-processed foods on health does not exist for Chile, it is clear from consumption surveys and other research that these represent a major cause of the health problems among Chileans (C. Corvalán, Reyes, Garmendia, & Uauy, 2013; Camila Corvalán, Uauy, Kain, & Martorell, 2010; Camila Corvalán, Uauy, Stein, Kain, & Martorell, 2009). These findings are consistent with the global consensus that links SSBs and energy dense ultra-processed foods as leading risk factors associated with obesity and overweight (Malik et al., 2010; Morenga, Mallard, & Mann, 2013; Tavares, Fonseca, Rosa, & Yokoo, 2012). In 2014, Chile led total SSBs consumption per capita per day worldwide, with the highest growth rate in the 2009–2014 period (B. M. Popkin & Hawkes, 2016). SSBs expenditure in Chilean households rose 151% between 1987 and 2007, to 289ml per capita per day (M. M. Crovetto & Uauy, 2014). At the same time, unhealthy foods high in sodium, saturated fats, sugar and refined carbohydrates (often termed 'junk' food or ultra-processed foods) represented 55.4% of total household food expenditures (M. Crovetto, Uauy, Martins, Moubarac, & Monteiro, 2014).

Several policies have been recommended and/or implemented to reduce SSBs and 'junk' food consumption in different countries and contexts, mainly focusing on front-of-package (FOP) food profiling and labelling, marketing restrictions, taxation, and removal of these foods and beverages from public institutions (Anand et al., 2015; Hawkes, 2007; Jou & Techakehakij, 2012; Sacks, Veerman, Moodie, & Swinburn, 2011; Thow, Downs, & Jan, 2014). Mexico, France, many of the Western Pacific Islands, Hungary, and Demark are among countries that have recently passed taxation laws to reduce consumption of these beverages and foods (Batis, Rivera, Popkin, & Taillie, 2015; Bíró, 2015; M Arantxa Colchero, Barry M Popkin, Juan A Rivera, & Shu Wen Ng, 2016; Smed, Scarborough, Rayner, & Jensen, 2016; Snowdon & Thow, 2013). In Chile, starting in September 2014, the tax rate for SSBs with sugar content higher than 15 grams per 240 ml or equivalent portion rose from 13% to 18%, and was reduced to 10% for other beverages (Servicio de Impuestos Internos, 2014). In the same line, Law 20.606, effective June 2016, tightened marketing regulations, FOP labelling and sale restrictions in school settings for energy-dense foods and beverages (Biblioteca del Congreso Nacional de Chile, 2015).

The focus of most of these tax initiatives has either been on SSBs, ‘junk' foods or foods high in unhealthy saturated fats with limited scientific evidence of the effect this policies have on consumption, with the exceptions of Mexico (M. A. Colchero, B. M. Popkin, J. A. Rivera, & S. W. Ng, 2016), Hungary (Biro, 2015) and Denmark (Jensen, Smed, Aarup, & Nielsen, 2015). However there is no comparative evidence of the potential for different tax scenarios, including taxation on SSBs alone, combined with ‘junk’ foods, or on sugar content, to understand which of these frameworks might be most effective. In this context, price-elasticities estimated from demand system models are a key element to measure the potential impact of alternative fiscal policies on expenditure for specific food groups. Although other factors such as households’ out-of-model behavior and industry marketing response also need to be considered when assessing counterfactuals for policy simulation, price-elasticities constitute a useful benchmark to analyze fiscal policy outcomes.

The objective of this study is twofold. First, it aims to jointly estimate own- and cross-price-elasticities of ‘junk’ foods and SSBs for Chilean urban households. Secondly, we assess the impact of a series of alternative tax schemes on expenditure and nutrient availability. Our paper expands the existing literature regarding quadratic almost ideal demand system models (QUAIDS), and its applications to ‘junk’ foods and SSBs taxation. Sensitivity analyses were conducted based on other model specifications. Results of this study contribute to the discussion on the current tax framework and the impact of future changes to reduce the prevalence of overweight and obesity in Chile.

2. Materials and Methods

2.1 Data

For this study we used the VII Income and Expenditure Survey (EPS, Spanish acronym) collected between 2011–2012, by the Chilean National Institute of Statistics (Instituto Nacional de Estadística de Chile, 2013). The EPS contains information regarding quantities and expenditure on all items used to construct the Consumer Price Index weights, and also reports socioeconomic and demographic information of the households (used to define poverty lines, among other applications). The EPS has a probabilistic, stratified, two stage sample design. The total sample size is 10,527 households. There are two representative zones identified in the survey: main capital and rest of the country.

2.2 Quadratic Almost Ideal Demand System (QUAIDS)

We seek to compare counterfactual policy changes on household purchases. Thus, it is relevant to consider a utility-based structural model, which models individual behavior in response to prices. To do this, we estimated the quadratic extension of the Almost Ideal Demand System model (Deaton & Muellbauer, 1980), introduced by (Banks, Blundell, & Lewbel, 1997), QUAIDS for short, which allows more flexibility over the income-expenditure (Engel) curves.

As noted by (Deaton & Muellbauer, 1980), some constraints had to be set over the model parameters in order to impose the 'rational consumer'. Specifically, homogeneity of degree zero on prices and income (if prices and income change in the same ratio, demand is unaffected) and symmetry (substitution or complementary effects between goods are symmetrical in direction and magnitude).

Household budget and expenditure surveys can include zero expenditure in certain food groups due to a number of reasons such as non-availability, non-preference, non-affordability or infrequent purchases. Because these reported zeros are likely selective, simply including them as zeros within the model would introduce bias. Thus, several approaches to solve this issue have been developed. In particular, (Shonkwiler & Yen, 1999) propose a two-step process according to a censored model.

Also, often prices and/or expenditure might be endogenous, meaning that expenditure shares and the explanatory variables might be jointly influenced by other factors. One of the main reasons for endogeneity is that prices are often measured as unit values, which are calculated as the ratio of expenditure over quantity. The latter implies that unit values also reflect different quality of the items purchased, thus being influenced by preferences (Deaton, 1988). If this is the case, an instrumental variable (IV) approach could be used to control for endogeneity in the model (Blundell & Robin, 1999).

In our case, we estimate the QUAIDS model for a rational consumer (using homogeneity and symmetry restrictions), and control for censored data (the households who do not purchase any given food or beverage group used) as our base model, using demographic shifts to allow for household heterogeneity. In particular, we used the age, gender and education of the head of household, as well as household location (zone), income quintile and size. Due to the limited sample size, there is a trade-off between the number of parameters to estimate and accounting for censored data, thus restrictions were needed to properly include households with zero expenditure for any food or beverage group.

For sensitivity analysis, we explore the unrestricted (myopic) model, and an extension of the same model, using IV approach to account for endogenous expenditure. Also, the base model was estimated for two sub-samples: low income households (first two income quintiles) and middle-high income (highest three income quintiles). Unfortunately, the analytic sample was too small to allow us to separate into more distinct/less heterogeneous households groups by income.

After estimating the parameters, the price-elasticities were computed for the median values of the variables (due to the high skewness of the data), and then were used to simulate three different tax scenarios. These three scenarios are based on current taxation and marketing concerns and the WHO push to reduce added sugar in our diets (World Health Organization, 2015). The three scenarios are:: (1) 40% price tax on SSBs; (2) a 5 cents per gram of sugar tax on products with added sugar; and (3) 30% price tax on all marketing controlled foods and beverages (based on Law 20.606, that regulates marketing and labelling for energy-dense foods and beverages). These taxes incorporate the current tax rate in 2011–2012, when the data was collected (13% price tax on all SSBs), although in 2014 the tax rate on SSBs increased to 18% for beverages with more than 15 grams of sugar per 240ml or equivalent portion, and 10% on all other SSBs. Therefore, in 2016 this would represent an increase of 22 or 12% for scenarios 1 and 3, respectively.

All models were estimated using STATA v.14.1. To estimate the QUAIDS two-step restricted and censoring adjusted base model, we used a modified version of the –nlsur- model, provided by (Poi, 2008), while for the unrestricted model, the –aidsills- command was used (Lecocq & Robin, 2015).

2.3 Variables

For this study, nine mutually exclusive groups of food and beverages were defined, in order to observe potential complementarities and substitutions: (1) sweets and desserts; (2) salty snacks and chips; (3) meat products and fats; (4) fruits, vegetables and seafood; (5) cereals and cereal products; (6) SSB ready-to-drink; (7) SSB from concentrate; (8) plain water, coffee and tea; and (9) milk. Groups (1) and (2) are considered ‘junk’ or market-controlled ultra-processed foods, groups (6) and (7) are SSBs, while groups (3), (4), (5), (8) and (9) represent healthier foods and beverages.

Food expenditure shares for each group were calculated adding expenditures within each group and then dividing it by total expenditure of the nine categories. Total expenditure among the selected food basket accounts, on average, for over ninety percent of total food expenditure, and it only excludes food items such as condiments and food away home. As proxy to prices, unit values were calculated as the ratio of expenditure over quantity for each food group. Adjustments were made for items that are consumed in a reconstituted form from powder or concentrate (M. M. Crovetto & Uauy, 2014). When expenditures were reported as zero, the missing unit value for that household was replaced by the average of households within the same zone and income level. To avoid extreme values (outlier) to affect calculations, when unit values exceeded +/−2.5 standard deviation for its own zone and income level, that value was replaced by +/−2.5 standard deviation. To account for household composition, adult equivalent units (EA) calculations were done as follows: for children under 5 years old equals to 0.77 EA; children from 6 through 12 years old equals to 0.80 EA, and adolescents from 13 to 18 years old accounts for 0.88 EA. This is standardized approach refined by FAOUN and the WHO (Food and Agriculture Organization of the United Nations., United Nations University., & World Health Organization., 2004).

In order to understand the impact of price changes on nutrient availability, nutritional information (calories, carbohydrates, sugar, sodium, protein, total fat and saturated fat) was linked to each item within each food and beverage group in the survey using a weighted average of a set of different foods and beverages available in different nutritional food panel sources relevant to the Chilean diet (U.S. Department of Agriculture, 2015; Universidad de Chile, 1992). In particular, the nutrient data for Chilean processed foods and beverages comes from a survey of 6,000 packaged and processed foods and beverages with bar codes collected in 2015 (INTA, 2015). Then, food group level nutritional values were calculated as a weighted average of the nutrients per 100 grams, based on average purchases of all food products within each food group. All results are expressed in absolute value, and also as a percentage of the median of nutrient availability per equivalent adult per day. Appendix table

A1 provides some statistics on the average nutrient content per 100g at the food group level. Appendix table A2 describes the upper nutrient limits and implementation dates for the upcoming marketing control and FOP labeling scheme. We used the strictest (to be implemented in June 2019) criteria as the basis for items to be taxed under the third tax scenario.

3. Results

Table 1 shows socio-demographic descriptive statistics. On average, low income households are more likely to have female heads of households with fewer years of education. Also, low income households are smaller (based on equivalent adults), meaning that there are less adults and/or more children compared to mid-high income households with the same number of people. Table 2 reports the median expenditure per food group across the full sample (appendix table A3 shows this by the two income groups). The large proportions of households without expenditures in selected food and beverage groups is highlighted the third column of Table 2. The snacks and chips, and SSBs from concentrate groups show the lowest percentage of households reporting purchases. In contrast, more than 85% of households report buying ready to drink (RTD) SSBs, and 92.5% indicate purchases of sweets and desserts. Sweets and desserts, as well as snack and chips are the groups with higher median unit value per kilo within the foods, while RTD SSBs are more expensive than other beverages.

In table 3 we show the mean unconditional price-elasticities from the estimated QUAIDS model adjusted for censored data (see appendix table A4 for full model estimation). Most food groups have elastic own-price elasticities, but the cereals and cereal products group, as well as sweets and desserts have inelastic own-price elasticities, while they together also represent an important part of the food expenditures in this model (36% from table 1). The own-price elasticity of SSBs ready to drink is elastic (−1.06), which means that for a 10% price increase, purchases would fall by 10.6% (assuming linearity). Other unhealthy items, such as salty snacks and chips, and SSBs from concentrate, show larger price-elasticities (in absolute value), but these are also the groups that account for the lowest proportion of households reporting expenditures and smaller expenditure shares overall. Cross price-elasticities show substitution and complementarity patterns among food groups. In particular, we observe important substitution between most food groups with the cereals and cereal products group. We also observe substitutions between SSBs ready to drink and the categories of healthier beverages (water, coffee, tea, milk). Finally, our model reports complementarities between SSB (ready to drink and from concentrate) and the meat products and fats group. Our results are robust to different model specifications, whether considering the myopic (unrestricted) model, and/or accounting for endogeneity in expenditures (see appendix table A5). Main differences arise from the fact that, when considering the censored nature of data, we include information regarding households that potentially purchase some food items at given prices, although not buying them during the time frame of the survey, thus price-elasticities estimates are lower than if we account for that expenditure as zero.

As seen in Figure 1, we note that for most of the less healthy food groups, low income households have a higher own-price elasticity, meaning that their consumption of SSBs and ‘junk’ foods after a tax would reduce relatively more than in mid-high income households. The only exception is SSBs from concentrate, where the own-price-elasticity in mid-high income households more than double the estimate for their low income counterpart.

Tables 4.1 and 4.2 shows the results of the three different tax scenarios. Table 4.1 indicates the total change in nutrient availability from changes on expenditure, and also the change in nutrient availability from unhealthy items (‘junk’ food and SSBs). Results are expressed as quantity variation (either grams or milligrams) but also as percentage of the total nutrient availability derived from expenditure in the food basket (using the median values). As an example, the 30% price tax on marketing controlled ‘junk’ foods and beverages yields a reduction of 14.6 grams of sugar per person per day (15% of median nutrient availability), and almost all of the decrease comes from ‘junk’ food and SSBs. On the other hand, the 5 cents per gram of sugar tax have a bigger reduction on sugar availability from ‘junk’ foods and SSBs (11.3 grams), but part of that is offset by higher consumption of healthier foods, thus the total change is 10 grams.

Table 4.2 indicates the change on nutrient availability per food group, measured in grams or milligrams. Overall, the tax on marketing controlled ‘junk’ foods and SSBs yields the highest effect on critical nutrient and calorie availability on households, coming from a reduction on both unhealthy and healthy foods and beverages (Figure 2). In this case, we note that while the reduction on sugar availability comes almost completely from the two forms of SSBs and junk foods, the reductions on calories, sodium and saturated fats comes from a significant expenditure drop on cereals and cereal products, and meat products and fats (some food items in this groups will also be included in the FOP labeling and marketing control scheme). The 40% SSBs tax has the lowest effect in diet overall, while the 5 cents per gram sugar tax has a significant effect on sugar and fats, but a limited impact on calories and sodium.

4. Discussion

This study was designed to examine three alternate tax models using income and expenditure data for Chile. Overall this study showed that a 30% tax on the market-controlled ultra-processed junk foods and beverages is linked with a much higher reduction in caloric intake as well as significant reductions in added sugar, sodium, and saturated fats. To obtain these results, the research utilized the estimates of a censored almost ideal demand system model for beverages and foods, from which price-elasticities and tax simulations were derived and simulated, respectively. We found own-price elasticities of −1.06 for RTD SSBs, −1.26 for SSBs from concentrate, −0.80 for sweets and desserts, and −1.99 for salty snacks and chips.

Our results are comparable with other studies based on a similar model specification (Table 5). The large differences between estimates are associated mostly with the modelling framework and data utilized (Andreyeva, Long, & Brownell, 2010). In general, studies show that SSBs are price-elastic, meaning that consumptions drops more than proportionally to price increases. Recent studies for Mexico and Ecuador report price-elasticities of −1.16 and −1.2 respectively (Colchero, Salgado, Unar-Munguía, Hernández-Ávila, & Rivera-Dommarco, 2015; Paraje, 2016). In contrast, evidence on price-elasticity for energy-dense processed foods is less conclusive, mainly because there is a lack of consensus regarding the definition of 'junk' food. (Zhen, Finkelstein, Nonnemaker, Karns, & Todd, 2014) reports price-elasticity of −1.67 to −1.1 for ice cream, candy, cakes and snacks, while (Colchero et al., 2015) finds similar results (−0.98 to −1.15 for candy and snacks).

By socioeconomic level, low income households report a higher own-price elasticity for RTD SSBs, sweets and desserts, and salty snacks, which is consistent with this items being relatively more expensive (compared to alternatives) and thus potentially being considered as 'luxury' for lower-income households. In the case of SSBs from concentrate, the own-price elasticity is significantly lower in low income households compared with their mid-high income counterparts. In this case, the opposite occurs; due to the low relative price of SSB concentrates compared to RTD SSBs and high average consumption, it appears that these types of beverages are considered part of the basic diet for low income households.

We note a complementarity between most unhealthy food groups and the meat products and oils group. This could be explained, in part, by cultural consumption patterns; a large part of meat consumption occurs during social gatherings where snacks, desserts and SSBs are often consumed as well. Also, there is a high substitution between all food groups and the cereal and cereal products group. We could argue that this happens, in part, because many foods could be home-produced using flour, and particularly, is expected that low income households substitute more expensive, less energy-dense but highly nutritious foods for lower price high-energy dense foods like refined cereals. On the other hand, the observed substitutions between beverages and cereals appear to be an artifact of the model specification – the model is unable to account for physical properties of foods versus beverage items and the differing satiation effects (DiMeglio & Mattes, 2000; Mattes, 1996; Mourao, Bressan, Campbell, Mattes, 2007), which is a limitation of the theoretical model.

Regarding tax simulations, we consider our results as a benchmark to compare alternative tax policy scenarios. Is particularly interesting that a tax based on the new marketing and labelling restriction regulation seems the most effective in terms of nutrient availability, compared to a higher SSBs tax or a tax per gram of sugar, especially because mandatory labelling might ease the process of identifying taxed items, if such tax scheme is implemented. Although not a part of this study, from the tax simulations presented here, is expected that the tax on marketing restricted foods will also yield the highest revenue, due to the broader tax base (on both 'junk' foods and SSBs). Lower income households are also predicted to lower their consumption of these unhealthy items to a greater extent compared to mid-high income household. Thus, this tax is not regressive in the sense that the poor who will buy much less of the tax items will pay less of the tax than higher income groups. It is also important to consider that additional fiscal earnings could be used in ways proven by evidence to enhance the impact of the tax, such as education programs or subsidies towards healthier foods or beverages. In particular, funds could be used to enhance acceptability and nutritional value of the school meal program, which currently covers school attending children in the 60% lowest income households with up to three meals a day (JUNAEB, 2015).

This work has several limitations. First, the data does not allow us to further separate food items that have added sugar from artificially sweetened products, e.g., we cannot separate regular sodas from diet sodas, although diet soda consumption in Chile represent less than 20% of total consumption (Euromonitor, 2015). A further limitation is our inability to separate healthier staples (e.g whole grains and legumes) from less healthy refined carbohydrate breads. Moreover the sample size plus the large proportion of non-consumers for some groups did not allow us to examine separately some of the healthier subcategories (e.g. legumes, poultry and fish). Sample size limitations did not allow us to differentiate more finely low, middle and higher income households. Also, we have no ability at this time to model or make assumptions about how the marketing control and FOP labelling scheme will affect our tax simulations; however it is possible that these laws will shift the structure of consumption and affect all three tax scenarios considered. As noted in the literature, our model does not control for endogeneity on expenditure or prices, because there was not sufficient local level disaggregated data to correct properly for this issue. Additionally, in our model we imposed symmetry and homogeneity restrictions (i.e., the rational model), due to the limited sample size, although is expected for this constraints not to be satisfied empirically. However, we note that, based on recent literature, the rejection of homogeneity restriction is often due to model specification rather that the true nature of data (B. R. Haag, Hoderlein, & Pendakur, 2009; B. R. Haag, Hordelein, & Mihaleva, 2009). Despite these limitations, the very large differences in kcal reduction from the 30% market-controlled food and beverage tax has such a higher impact that we do not think the additions of these taxes and other regulations will change the relative impact of each tax on nutrient intake and thus the general conclusions of the study.

Finally, is important to consider that our model does not account for other types of household and industry behavior. In particular individuals could switch between different product varieties with significantly different nutrient composition, moving to items with lower price and lesser nutritional value. Also, we cannot in any way examine leakages in the system (e.g. black marketing of selected products or bringing across the border untaxed items illegally). However, unlike cigarettes, food and beverage items are fairly bulky and we do not expect excessive smuggling or other similar leakages. In addition, the FOP labelling scheme is expected to provide important insights regarding the current food supply before a new tax is implemented, so the problems with delineation of unhealthy products will be clarified by the authorities. Finally, in our simulations we assume that the tax is fully transmitted to retail prices uniformly, without considering strategic firm behavior.

Improving the diet of any country is a very complex process. Globally, the shift towards highly processed diets with excessive sodium, added sugar, unhealthy fats and highly refined carbohydrates has defined the global dietary shift of the past several decades (Monteiro, Moubarac, Cannon, Ng, & Popkin, 2013; Barry M. Popkin, Adair, & Ng, 2012; Poti, Mendez, Ng, & Popkin, 2015). A new paradigm involving much healthier diets requires a large number of changes, including ultimately shifts in the culture of eating, a reduction of marketing of unhealthy foods and beverages, FOP labeling of either healthy or unhealthy foods and beverages, and shifts in the relative prices to encourage significant changes toward healthier food purchases (Anand et al., 2015). Chile is unique in currently having instituted one smaller SSB price increase and using both marketing controls and FOP labeling of unhealthy foods and beverages to begin this process (C. Corvalán et al., 2013). The design of a larger tax to enhance the overall effect into a healthier Chilean diet is a next critical step. This study has shown that a large tax (a 30% on market-controlled foods and an additional 12% on SSB's) on the same foods and beverages delineated as less healthy by the marketing controls and FOP labeling should prove to be more effective, and yield higher revenues potentially to be used towards public health promotion and investments. Clearly if such a tax is implemented, rigorous careful evaluation is needed to understand if it achieves its goals.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Appendix

QUAIDS model specification

The QUAIDS model in its budget share form is defined as follows:

$$w_i=\alpha_i+\sum_{k\in K}\rho_k z_k+\sum_{j\in I}\gamma_{\mathrm{ij}}\ \ln\ p_j+\beta_i\left(\ln\ \left(\frac{m}{a(p)}\right)\right)+\frac{\lambda_i}{b(p)}\left(\ln\ \left(\frac{m}{a(p)}\right)\right)^2+\mu_i \quad (1)$$

With the nonlinear price aggregators:

$$\ln\ a(p)=\alpha_0+\sum_{j\in I}\alpha_j\ \ln\ p_j+\frac{1}{2}\sum_{l\in I}\sum_{j\in I}\gamma_{\mathrm{lj}}\ ln\ p_l\ \ln\ p_j \quad (2)$$

$$b(p)=\prod_{j\in I}p_j^{\beta_j}, \quad (3)$$

where w_i, p_i and m are budget share and price of the food item group i, and the total food expenditure per household, respectively. I represents the set of all food groups. z_k is a set of sociodemographic variables introduced to allow household heterogeneity.

In order to impose economic rationality, parameters need to be constrained to allow homogeneity of degree zero on prices and income (if prices and income change in the same ratio, demand is unaffected) and symmetry (substitution or complementary effects between goods are symmetrical in direction and magnitude). In particular these constraints are:

$$\sum_{i\in I}\alpha_i=1;\ \sum_{i\in I}\beta_i=0;\ \sum_{i\in I}\gamma_{\mathrm{ij}}=0;\ \sum_{j\in J}\gamma_{\mathrm{ij}}=0;\ \gamma_{\mathrm{ij}}=\gamma_{\mathrm{ji}} \quad (4)$$

First, a probit model is estimated and used to predict the cumulative distribution (Φ) and probability density functions (ϕ) for each household. Then, this information is used in the second step to modify Equation 1 as follows:

$$w_i^* = \hat{\Phi}_i w_i + \delta_i \hat{\phi}_i \quad (5)$$

Table A1

Food group description and average nutrient content per 100 grams

Food group	Description	Kcal	sugar (g.)	sodium (mg.)	fat (g.)	saturated fat (g.)	protein (g.)
Sweets and desserts[†‡]	Pastries, chocolate, candy, ice cream, yogurts, desserts, breakfast cereals	294.9	39.9	106.3	7.9	3.9	3.5
Salty snacks and chips[‡]	Cocktail items, potato chips	518.2	1.7	585.2	29.4	3.8	6.1
Meat products and fats	Meats, sausages, patties, oils, butter, margarine	295.1	0.5	352.6	25.3	8.4	15.8
F+V and seafood	All fresh and frozen fruits and vegetables, pulses and seafood	68.7	4.6	48.7	1.8	0.3	3.5
Cereals and cereal products	Bread, rice, flour and pasta	244.9	1.3	189.9	2.3	0.6	8.7
SSB ready-to-drink[*†‡]	Sodas, juices, nectars and flavored waters	37.4	9.0	13.0	0.0	0.0	0.3
SSB concentrate[*†‡]	Juices based on powder or concentrate	14.3	3.3	11.0	0.0	0.0	0.6
Water, coffee and tea	Bottled water, coffee, tea and infusions	0.7	0.0	2.2	0.0	0.0	0.0
Milk	Whole milk only	46.9	4.8	59.2	1.6	1.0	3.1

Note: Calculations based on median purchases per household and reconstituted foods. F+V: fruits and vegetables. SSBs from concentrate are considered in the 'junk' food tax given that some items are affected by the FOP labelling scheme.

[*]Subject to 40% SSBs tax

[†]Subject to 5 cents per gram of sugar tax

[‡]Subject to 30% tax on marketing controlled food and beverages ('junk' food tax).

Table A2

Nutrient limits and implementation dates (from June 2016) for marketing control and FOP labelling scheme in Chile

	June 2017	June 2018	June 2019
A. Foods			
Energy, kcal/100 g	350.0	300.0	275.0
Sodium, mg/100 g	800.0	500.0	400.0
Total sugar, g/100 g	22.5	15.0	10.0
Saturated fat, g/100 g	6.0	5.0	4.0
B. Beverages			
Energy, kcal/100 g	100.0	80.0	70.0
Sodium, mg/100 g	100.0	100.0	100.0
Total sugar, g/100 g	6.0	5.0	5.0
Saturated fat, g/100 g	3.0	3.0	3.0

Table A3

Expenditure statistics by socioeconomic group (in ml or gr.)

	Low Income (4,697 obs.)			Mid-High Income (5,786 obs.)		
Item	Mean expenditure share	Median quantity per capita (all households)	Expenditure > 0 (%)	Mean expenditure share	Median quantity per capita (all households)	Expenditure > 0 (%)
Sweets and desserts	0.13	90	88%	0.16	119	96%
Salty snacks and chips	0.03	5	25%	0.03	6	41%
Meat products and fats	0.33	163	97%	0.34	198	98%
F+V and seafood	0.19	316	94%	0.19	359	96%
cereals and cereal products	0.26	368	99%	0.18	310	99%
SSB, ready to drink	0.10	213	80%	0.10	260	89%
SSB, concentrate	0.02	206	36%	0.02	239	35%
Water, coffee and tea	0.04	548	41%	0.03	531	55%
Milk	0.05	83	46%	0.05	114	59%

Table A4

QUAIDS model estimation

	Coefficient	Standard error	Z-score	P-value	95% Confidence Interval	
alpha1	0.156917	0.009675	16.22	0	0.137955	0.17588
alpha2	0.054637	0.005108	10.7	0	0.044626	0.064649
alpha3	0.077819	0.031662	2.46	0.014	0.015763	0.139874
alpha4	0.20226	0.020077	10.07	0	0.162909	0.241611
alpha5	0.310397	0.034944	8.88	0	0.241907	0.378886
alpha6	0.098389	0.007818	12.58	0	0.083065	0.113712
alpha7	0.04446	0.00598	7.44	0	0.03274	0.05618
alpha8	0.022467	0.004128	5.44	0	0.014377	0.030558
beta1	0.010198	0.003076	3.32	0.001	0.004169	0.016227
beta2	0.003222	0.000956	3.37	0.001	0.001349	0.005095
beta3	0.063902	0.00385	16.6	0	0.056356	0.071448
beta4	0.021873	0.003192	6.85	0	0.015617	0.02813
beta5	−0.10053	0.003349	−30.02	0	−0.1071	−0.09397
beta6	0.000853	0.002608	0.33	0.744	−0.00426	0.005965
beta7	−0.00136	0.000569	−2.4	0.017	−0.00248	−0.00025
beta8	0.001152	0.001061	1.09	0.278	−0.00093	0.003233
gamma11	0.029236	0.00228	12.82	0	0.024768	0.033705
gamma12	0.002928	0.00073	4.01	0	0.001497	0.004358
gamma13	−0.02397	0.00255	−9.4	0	−0.02897	−0.01897
gamma14	0.004318	0.001929	2.24	0.025	0.000537	0.008098

	Coefficient	Standard error	Z-score	P-value	95% Confidence Interval	
gamma15	−0.01712	0.002226	−7.69	0	−0.02148	−0.01275
gamma16	0.009283	0.001575	5.89	0	0.006196	0.01237
gamma17	−0.0001	0.000419	−0.24	0.807	−0.00092	0.000719
gamma18	0.000172	0.000689	0.25	0.803	−0.00118	0.001522
gamma22	−0.0147	0.001963	−7.49	0	−0.01855	−0.01085
gamma23	−0.00029	0.001502	−0.19	0.847	−0.00323	0.002653
gamma24	0.00224	0.001009	2.22	0.026	0.000262	0.004218
gamma25	0.004875	0.001409	3.46	0.001	0.002113	0.007637
gamma26	−0.00294	0.000999	−2.94	0.003	−0.00489	−0.00098
gamma27	0.001458	0.000981	1.49	0.137	−0.00046	0.003381
gamma28	0.002006	0.000434	4.62	0	0.001155	0.002856
gamma33	0.005659	0.006337	0.89	0.372	−0.00676	0.018079
gamma34	0.027318	0.003308	8.26	0	0.020835	0.033801
gamma35	0.002082	0.004488	0.46	0.643	−0.00671	0.010879
gamma36	−0.01942	0.0028	−6.93	0	−0.0249	−0.01393
gamma37	−0.00252	0.000949	−2.66	0.008	−0.00438	−0.00066
gamma38	0.002763	0.001181	2.34	0.019	0.000449	0.005077
gamma44	−0.00919	0.00377	−2.44	0.015	−0.01658	−0.0018
gamma45	−0.03259	0.003178	−10.26	0	−0.03882	−0.02636
gamma46	0.003985	0.00213	1.87	0.061	−0.00019	0.008159
gamma47	0.000131	0.000626	0.21	0.834	−0.0011	0.001358
gamma48	0.004236	0.000901	4.7	0	0.00247	0.006002
gamma55	0.024921	0.005384	4.63	0	0.014368	0.035474
gamma56	0.004628	0.002561	1.81	0.071	−0.00039	0.009648
gamma57	0.003127	0.000898	3.48	0	0.001368	0.004886
gamma58	−0.0096	0.0011	−8.72	0	−0.01175	−0.00744
gamma66	−0.0079	0.002774	−2.85	0.004	−0.01334	−0.00246
gamma67	0.000934	0.000635	1.47	0.141	−0.00031	0.002178
gamma68	0.006444	0.000804	8.02	0	0.004868	0.00802
gamma77	−0.00285	0.001317	−2.17	0.03	−0.00543	−0.00027
gamma78	−0.00032	0.000274	−1.16	0.247	−0.00086	0.00022
gamma88	−0.00827	0.000559	−14.8	0	−0.00936	−0.00718
lambda1	0.002854	0.001164	2.45	0.014	0.000572	0.005136
lambda2	0.002306	0.000354	6.52	0	0.001613	0.003
lambda3	−0.00381	0.001438	−2.65	0.008	−0.00663	−0.00099
lambda4	−0.00164	0.001207	−1.36	0.174	−0.00401	0.000723
lambda5	−0.01069	0.001208	−8.85	0	−0.01306	−0.00832
lambda6	0.010927	0.000907	12.05	0	0.00915	0.012705
lambda7	−0.00081	0.000216	−3.74	0	−0.00123	−0.00039
lambda8	0.002153	0.000393	5.48	0	0.001383	0.002923
delta1	0.080933	0.028034	2.89	0.004	0.025987	0.135878
delta2	−0.00886	0.005619	−1.58	0.115	−0.01987	0.002151

	Coefficient	Standard error	Z-score	P-value	95% Confidence Interval	
delta3	1.384618	0.103564	13.37	0	1.181636	1.587601
delta4	0.133869	0.065418	2.05	0.041	0.005651	0.262086
delta5	−0.67972	0.118286	−5.75	0	−0.91155	−0.44788
delta6	0.032428	0.014808	2.19	0.029	0.003405	0.061452
delta7	−0.05752	0.004943	−11.64	0	−0.06721	−0.04784
delta8	−0.01792	0.006013	−2.98	0.003	−0.02971	−0.00613

Note: parameters for sociodemographic controls (Z) not presented.

Table A5.1

Uncompensated elasticities from QUAIDS model (unrestricted, not controlling for censored data)

	Change in price								
Change in quantity	**Sweets and desserts**	**Salty snacks and chips**	**Meat products and fats**	**F+V and seafood**	**cereals and cereal products**	**SSB, ready to drink**	**SSB, concentrate**	**Water, coffee and tea**	**Milk**
Sweets and desserts	−0.813***	0.021	0.119***	0.054**	0.357***	0.109***	0.137*	−0.009	−0.029
	−0.013	−0.035	−0.031	−0.02	−0.028	−0.02	−0.065	−0.009	−0.029
Salty snacks and chips	0.287***	−2.032***	0.307**	0.145*	0.394***	−0.034	0.299	0.151***	0.293**
	−0.044	−0.117	−0.102	−0.065	−0.092	−0.065	−0.212	−0.029	−0.096
Meat products and fats	−0.042***	0.043*	−0.834***	0.077***	−0.018	−0.061***	−0.024	−0.012*	−0.004
	−0.008	−0.02	−0.018	−0.012	−0.016	−0.011	−0.037	−0.005	−0.017
F+V and seafood	−0.008	−0.006	0.060*	−1.039***	−0.312***	0.018	0.012	0.012	0.01
	−0.011	−0.029	−0.026	−0.017	−0.024	−0.017	−0.054	−0.007	−0.024
cereals and cereal products	−0.091***	−0.072**	−0.386***	−0.135***	−1.090***	0.001	−0.128**	−0.004	0.138***
	−0.009	−0.025	−0.022	−0.014	−0.02	−0.014	−0.046	−0.006	−0.021
SSB, ready to drink	0.118***	−0.116*	−0.012	−0.017	0.082*	−1.103***	0.142	0.116***	0.233***
	−0.018	−0.048	−0.043	−0.028	−0.039	−0.027	−0.089	−0.012	−0.04
SSB, concentrate	−0.073*	0.138	−0.500***	−0.006	0.041	0.075	−2.749***	−0.052*	−0.023
	−0.035	−0.092	−0.083	−0.053	−0.075	−0.052	−0.176	−0.023	−0.078
Water, coffee and tea	−0.019	0.532***	0.332***	0.121*	0.426***	0.125*	0.414*	−1.446***	0.047
	−0.034	−0.091	−0.081	−0.052	−0.073	−0.051	−0.168	−0.025	−0.076
Milk	−0.070**	0.258***	−0.079	0.035	0.425***	0.213***	0.188	0.011	−2.323***
	−0.025	−0.065	−0.058	−0.037	−0.053	−0.037	−0.121	−0.016	−0.06

p<0.05* p<0.01** p<0.001***

Table A5.2

Uncompensated elasticities from QUAIDS model (unrestricted, endogenous expenditure, not controlling for censored data)

	Change in price								
Change in quantity	**Sweets and desserts**	**Salty snacks and chips**	**Meat products and fats**	**F+V and seafood**	**cereals and cereal products**	**SSB, ready to drink**	**SSB, concentrate**	**Water, coffee and tea**	**Milk**
Sweets and desserts	−0.847 ***	0.017	−0.105 ***	0.022	−0.055 *	0.054 **	−0.003	−0.009	−0.028
	−0.013	−0.032	−0.029	−0.019	−0.027	−0.019	−0.043	−0.008	−0.025
Salty snacks and chips	0.244 ***	−2.454 ***	0	0.174 *	0.341 **	−0.235 **	0.154	0.122 ***	0.4 ***
	−0.052	−0.141	−0.115	−0.076	−0.106	−0.075	−0.169	−0.032	−0.101
Meat products and fats	−0.056 ***	0.002	−0.888 ***	0.070 ***	−0.069 ***	−0.055 ***	−0.007	−0.006	−0.011
	−0.007	−0.017	−0.016	−0.01	−0.015	−0.01	−0.023	−0.004	−0.014
F+V and seafood	0.019	0.01	0.147 ***	−1.009 ***	−0.141 ***	0.009	0.002	0.013	0.013
	−0.011	−0.026	−0.024	−0.016	−0.022	−0.016	−0.035	−0.007	−0.021
cereals and cereal products	−0.049 ***	0.015	−0.111 ***	−0.144 ***	−0.892 ***	0.008	0.02	0.005	0.10 ***
	−0.009	−0.022	−0.02	−0.013	−0.018	−0.013	−0.029	−0.006	−0.017
SSB, ready to drink	0.096 ***	−0.023	−0.215 ***	0.015	0.038	−1.036 ***	0.009	0.061 ***	0.078 *
	−0.019	−0.046	−0.042	−0.027	−0.038	−0.027	−0.061	−0.012	−0.036
SSB, concentrate	−0.118 **	0.167	−0.414 ***	−0.027	0.499 ***	0.062	−1.501 ***	−0.068 **	0.045
	−0.04	−0.096	−0.089	−0.057	−0.081	−0.057	−0.127	−0.025	−0.075
Water, coffee and tea	−0.054	0.064	−0.049	0.164 ***	0.11	0.292 ***	−0.027	−1.389 ***	0.07
	−0.033	−0.079	−0.071	−0.047	−0.066	−0.048	−0.105	−0.024	−0.062
Milk	−0.188 ***	0.154 *	−0.177 **	0.074	0.907 ***	0.248 ***	0.017	0.046 **	−2.10 ***
	−0.03	−0.071	−0.065	−0.042	−0.058	−0.043	−0.094	−0.018	−0.058

p<0.05* p<0.01** p<0.001***

Table A6.1

Tax simulation results for nutrient availability (low income group)

	40% tax SSBs				*5 cents per gram of sugar*				*30% tax junk food*			
	total var.	*%*	*JF var.*	*%*	**total var.**	*%*	*JF var.*	*%*	**total var.**	*%*	*JF var.*	*%*
kcal	42.54	*3%*	2.44	*0%*	21.96	*1%*	−24.05	*−2%*	−736.81	*−46%*	−135.84	*−9%*
carbs	13.29	*6%*	−0.57	*0%*	12.83	*6%*	−5.28	*−2%*	−102.74	*−46%*	−25.86	*−12%*
sugar	−0.03	*0%*	−1.21	*−2%*	−2.56	*−4%*	−4.79	*−8%*	−27.60	*−48%*	−20.48	*−35%*
sodium	16.96	*1%*	−0.35	*0%*	3.49	*0%*	−10.78	*−1%*	−609.13	*−53%*	−62.55	*−5%*
fats	−1.63	*−4%*	0.47	*1%*	−3.51	*−8%*	−0.24	*−1%*	−24.42	*−55%*	−3.03	*−7%*
sat. fats	−0.52	*−4%*	0.23	*2%*	−1.31	*−9%*	−0.13	*−1%*	−7.92	*−56%*	−1.24	*−9%*
protein	0.97	*2%*	−0.04	*0%*	0.67	*1%*	−0.45	*−1%*	−27.78	*−46%*	−1.82	*−3%*

Note: UI: Unhealthy Items: junk food and SSBs. Variation as percentage (%) is reported based on the median availability by purchases.

Table A6.2

Tax simulation results for nutrient availability (mid-high income group)

	40% tax SSBs				5 cents per gram of sugar				30% tax junk food			
	total var.	%	JF var.	%	total var.	%	JF var.	%	total var.	%	JF var.	%
kcal	9.83	1%	−26.47	−2%	−35.03	−2%	−93.18	−6%	−263.96	−16%	−83.64	−5%
carbs	5.82	3%	−6.82	−3%	2.62	1%	−19.61	−9%	−43.20	−19%	−15.39	−7%
sugar	−6.29	−9%	−6.87	−9%	−16.28	−22%	−17.32	−24%	−11.17	−15%	−11.70	−16%
sodium	2.50	0%	−12.59	−1%	−19.75	−2%	−39.12	−3%	−196.86	−15%	−40.95	−3%
fats	−1.79	−3%	0.15	0%	−5.15	−10%	−1.26	−2%	−6.49	−12%	−2.09	−4%
sat. fats	−0.67	−4%	0.03	0%	−2.11	−11%	−0.71	−4%	−2.19	−12%	−0.79	−4%
protein	0.19	0%	−0.61	−1%	−0.58	−1%	−1.69	−3%	−7.88	−12%	−1.10	−2%

Note: UI: Unhealthy Items: junk food and SSBs. Variation as percentage (%) is reported based on the median availability by purchases.

Table A6.3

Tax simulation results for nutrient availability by food group (low income group)

		40% tax on SSBs			5 cents per gram of sugar			30% tax on junk food		
		mean	95% CI		mean	95% CI		mean	95% CI	
Sweets and desserts	kcal	17.1	5.7	28.5	−10.1	−30.3	10.2	−86.4	−111.9	−61.0
	carbs	3.1	1.0	5.1	−1.8	−5.4	1.8	−15.4	−20.0	−10.9
	sugar	2.3	0.8	3.9	−1.4	−4.1	1.4	−11.7	−15.1	−8.2
	sodium	6.2	2.1	10.3	−3.6	−10.9	3.7	−31.2	−40.3	−22.0
	fats	0.5	0.2	0.8	−0.3	−0.8	0.3	−2.3	−3.0	−1.6
	sat. fats	0.2	0.1	0.4	−0.1	−0.4	0.1	−1.1	−1.5	−0.8
	protein	0.2	0.1	0.3	−0.1	−0.4	0.1	−1.0	−1.3	−0.7
Salty snacks and chips	kcal	0.1	−1.6	1.9	0.5	−2.7	3.7	−12.6	−16.0	−9.3
	carbs	0.0	−0.2	0.2	0.1	−0.3	0.4	−1.4	−1.8	−1.0
	sugar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.1	0.0
	sodium	0.2	−1.8	2.1	0.6	−3.0	4.2	−14.3	−18.1	−10.5
	fats	0.0	−0.1	0.1	0.0	−0.2	0.2	−0.7	−0.9	−0.5
	sat. fats	0.0	0.0	0.0	0.0	0.0	0.0	−0.1	−0.1	−0.1
	protein	0.0	0.0	0.0	0.0	0.0	0.0	−0.1	−0.2	−0.1
Meat products and fats	kcal	−35.3	−70.2	−0.4	−54.7	−116.6	7.1	−189.9	−269.7	−110.1
	carbs	−0.1	−0.2	0.0	−0.2	−0.4	0.0	−0.6	−0.8	−0.3
	sugar	−0.1	−0.1	0.0	−0.1	−0.2	0.0	−0.3	−0.5	−0.2
	sodium	−42.2	−83.9	−0.5	−65.4	−139.3	8.5	−226.9	−322.2	−131.5
	fats	−3.0	−6.0	0.0	−4.7	−10.0	0.6	−16.3	−23.1	−9.4
	sat. fats	−1.0	−2.0	0.0	−1.6	−3.3	0.2	−5.4	−7.7	−3.1
	protein	−1.9	−3.8	0.0	−2.9	−6.2	0.4	−10.2	−14.4	−5.9

		40% tax on SSBs			5 cents per gram of sugar			30% tax on junk food		
		mean	95% CI		mean	95% CI		mean	95% CI	
F+V and seafood	kcal	9.4	−2.7	21.6	21.3	−0.2	42.7	−62.3	−88.8	−35.7
	carbs	1.5	−0.4	3.5	3.4	0.0	6.8	−10.0	−14.2	−5.7
	sugar	0.6	−0.2	1.4	1.4	0.0	2.9	−4.2	−5.9	−2.4
	sodium	6.7	−1.9	15.3	15.1	−0.1	30.3	−44.1	−63.0	−25.3
	fats	0.2	−0.1	0.6	0.6	0.0	1.1	−1.6	−2.3	−0.9
	sat. fats	0.0	0.0	0.1	0.1	0.0	0.2	−0.3	−0.4	−0.2
	protein	0.5	−0.1	1.1	1.1	0.0	2.2	−3.2	−4.5	−1.8
Cereal and cereal products	kcal	63.1	0.6	125.7	74.3	−36.6	185.2	−340.2	−498.5	−182.0
	carbs	12.1	0.1	24.1	14.3	−7.0	35.5	−65.3	−95.7	−34.9
	sugar	0.3	0.0	0.7	0.4	−0.2	1.0	−1.8	−2.6	−1.0
	sodium	48.9	0.4	97.5	57.6	−28.4	143.6	−263.8	−386.5	−141.1
	fats	0.6	0.0	1.2	0.7	−0.3	1.7	−3.2	−4.7	−1.7
	sat. fats	0.2	0.0	0.3	0.2	−0.1	0.5	−0.8	−1.2	−0.4
	protein	2.2	0.0	4.5	2.6	−1.3	6.6	−12.1	−17.7	−6.5
SSB, ready to drink	kcal	−11.2	−15.3	−7.1	−8.1	−15.3	−0.9	−26.5	−34.6	−18.3
	carbs	−2.8	−3.8	−1.8	−2.0	−3.8	−0.2	−6.6	−8.6	−4.6
	sugar	−2.7	−3.7	−1.7	−1.9	−3.7	−0.2	−6.4	−8.3	−4.4
	sodium	−3.9	−5.3	−2.5	−2.8	−5.3	−0.3	−9.2	−12.0	−6.4
	fats	0.0			0.0			0.0		
	sat. fats	0.0			0.0			0.0		
	protein	−0.1	−0.1	−0.1	−0.1	−0.1	0.0	−0.2	−0.3	−0.1
SSB, concentrate	kcal	−3.6	−5.9	−1.3	−6.4	−10.6	−2.3	−10.3	−13.2	−7.4
	carbs	−0.9	−1.4	−0.3	−1.5	−2.5	−0.5	−2.4	−3.1	−1.8
	sugar	−0.8	−1.4	−0.3	−1.5	−2.4	−0.5	−2.4	−3.0	−1.7
	sodium	−2.8	−4.6	−1.0	−4.9	−8.1	−1.8	−7.9	−10.1	−5.7
	fats	0.0			0.0			0.0		
	sat. fats	0.0			0.0			0.0		
	protein	−0.2	−0.2	−0.1	−0.3	−0.4	−0.1	−0.4	−0.6	−0.3
Water, coffee and tea	kcal	0.1	0.0	0.2	0.2	0.0	0.4	−0.5	−0.7	−0.3
	carbs	0.0	0.0	0.1	0.1	0.0	0.1	−0.1	−0.2	−0.1
	sugar	0.0			0.0			0.0		
	sodium	0.4	0.1	0.8	0.7	0.1	1.3	−1.5	−2.2	−0.8
	fats	0.0			0.0			0.0		
	sat. fats	0.0			0.0			0.0		
	protein	0.0			0.0			0.0		
Milk	kcal	2.7	0.5	4.9	4.9	1.0	8.9	−8.1	−12.3	−3.9
	carbs	0.3	0.1	0.5	0.5	0.1	1.0	−0.9	−1.4	−0.4

		40% tax on SSBs			5 cents per gram of sugar			30% tax on junk food		
		mean	95% CI		mean	95% CI		mean	95% CI	
	sugar	**0.3**	**0.1**	**0.5**	**0.5**	**0.1**	**0.9**	**−0.8**	**−1.3**	**−0.4**
	sodium	**3.4**	**0.6**	**6.2**	**6.2**	**1.2**	**11.3**	**−10.2**	**−15.5**	**−4.9**
	fats	**0.1**	**0.0**	**0.2**	**0.2**	**0.0**	**0.3**	**−0.3**	**−0.4**	**−0.1**
	sat. fats	**0.1**	**0.0**	**0.1**	**0.1**	**0.0**	**0.2**	**−0.2**	**−0.3**	**−0.1**
	protein	**0.2**	**0.0**	**0.3**	**0.3**	**0.1**	**0.6**	**−0.5**	**−0.8**	**−0.3**

Note: significant values to 95% in bold.

Table A6.4

Tax simulation results for nutrient availability by food group (mid-high income group)

		40% tax on SSBs			5 cents per gram of sugar			30% tax on junk food		
		mean	95% CI		mean	95% CI		mean	95% CI	
Sweets and desserts	kcal	0.9	−11.5	13.4	**−55.8**	**−77.7**	**−33.8**	**−53.7**	**−70.9**	**−36.5**
	carbs	0.2	−2.1	2.4	**−10.0**	**−13.9**	**−6.0**	**−9.6**	**−12.7**	**−6.5**
	sugar	0.1	−1.6	1.8	**−7.5**	**−10.5**	**−4.6**	**−7.3**	**−9.6**	**−4.9**
	sodium	0.3	−4.1	4.8	**−20.1**	**−28.0**	**−12.2**	**−19.4**	**−25.5**	**−13.2**
	fats	0.0	−0.3	0.4	**−1.5**	**−2.1**	**−0.9**	**−1.4**	**−1.9**	**−1.0**
	sat. fats	0.0	−0.2	0.2	**−0.7**	**−1.0**	**−0.4**	**−0.7**	**−0.9**	**−0.5**
	protein	0.0	−0.1	0.2	**−0.7**	**−0.9**	**−0.4**	**−0.6**	**−0.8**	**−0.4**
Salty snacks and chips	kcal	**2.2**	**0.7**	**3.7**	**4.2**	**1.5**	**6.8**	**−11.4**	**−13.5**	**−9.4**
	carbs	**0.2**	**0.1**	**0.4**	**0.5**	**0.2**	**0.7**	**−1.2**	**−1.5**	**−1.0**
	sugar	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
	sodium	**2.5**	**0.8**	**4.1**	**4.7**	**1.7**	**7.7**	**−12.9**	**−15.2**	**−10.6**
	fats	**0.1**	**0.0**	**0.2**	**0.2**	**0.1**	**0.4**	**−0.6**	**−0.8**	**−0.5**
	sat. fats	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	**−0.1**	**−0.1**	**−0.1**
	protein	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	**−0.1**	**−0.2**	**−0.1**
Meat products and fats	kcal	−30.8	−64.5	2.8	**−60.0**	**−119.9**	**−0.2**	−40.2	−84.6	4.2
	carbs	−0.1	−0.2	0.0	**−0.2**	**−0.4**	**0.0**	−0.1	−0.3	0.0
	sugar	−0.1	−0.1	0.0	**−0.1**	**−0.2**	**0.0**	−0.1	−0.1	0.0
	sodium	−36.8	−77.0	3.4	**−71.7**	**−143.3**	**−0.2**	−48.1	−101.1	5.0
	fats	−2.6	−5.5	0.2	**−5.1**	**−10.3**	**0.0**	−3.4	−7.3	0.4
	sat. fats	−0.9	−1.8	0.1	**−1.7**	**−3.4**	**0.0**	−1.1	−2.4	0.1
	protein	−1.7	−3.5	0.2	**−3.2**	**−6.4**	**0.0**	−2.2	−4.5	0.2
F+V and seafood	kcal	4.1	−6.0	14.2	8.3	−9.5	26.1	**16.4**	**2.9**	**29.9**
	carbs	0.7	−1.0	2.3	1.3	−1.5	4.2	**2.6**	**0.5**	**4.8**
	sugar	0.3	−0.4	0.9	0.6	−0.6	1.7	**1.1**	**0.2**	**2.0**
	sodium	2.9	−4.3	10.0	5.9	−6.7	18.5	**11.6**	**2.0**	**21.2**
	fats	0.1	−0.2	0.4	0.2	−0.2	0.7	**0.4**	**0.1**	**0.8**

		40% tax on SSBs			*5 cents per gram of sugar*			*30% tax on junk food*		
		mean	**95% CI**		**mean**	**95% CI**		**mean**	**95% CI**	
	sat. fats	0.0	0.0	0.1	0.0	0.0	0.1	**0.1**	**0.0**	**0.1**
	protein	0.2	−0.3	0.7	0.4	−0.5	1.3	**0.8**	**0.1**	**1.5**
Cereal and cereal products	kcal	**62.8**	**23.7**	**102.0**	**109.8**	**40.2**	**179.5**	**−160.1**	**−222.4**	**−97.7**
	carbs	**12.1**	**4.5**	**19.6**	**21.1**	**7.7**	**34.5**	**−30.7**	**−42.7**	**−18.7**
	sugar	**0.3**	**0.1**	**0.5**	**0.6**	**0.2**	**1.0**	**−0.8**	**−1.2**	**−0.5**
	sodium	**48.7**	**18.3**	**79.1**	**85.2**	**31.2**	**139.2**	**−124.1**	**−172.5**	**−75.8**
	fats	**0.6**	**0.2**	**1.0**	**1.0**	**0.4**	**1.7**	**−1.5**	**−2.1**	**−0.9**
	sat. fats	**0.2**	**0.1**	**0.2**	**0.3**	**0.1**	**0.4**	**−0.4**	**−0.5**	**−0.2**
	protein	**2.2**	**0.8**	**3.6**	**3.9**	**1.4**	**6.4**	**−5.7**	**−7.9**	**−3.5**
SSB, ready to drink	kcal	**−17.5**	**−21.0**	**−13.9**	**−19.6**	**−25.8**	**−13.4**	**−13.1**	**−17.8**	**−8.5**
	carbs	**−4.3**	**−5.2**	**−3.5**	**−4.9**	**−6.4**	**−3.3**	**−3.3**	**−4.4**	**−2.1**
	sugar	**−4.2**	**−5.1**	**−3.4**	**−4.7**	**−6.2**	**−3.2**	**−3.2**	**−4.3**	**−2.0**
	sodium	**−6.1**	**−7.3**	**−4.8**	**−6.8**	**−9.0**	**−4.6**	**−4.6**	**−6.2**	**−3.0**
	fats	**0.0**			**0.0**			**0.0**		
	sat. fats	**0.0**			**0.0**			**0.0**		
	protein	**−0.1**	**−0.2**	**−0.1**	**−0.2**	**−0.2**	**−0.1**	**−0.1**	**−0.1**	**−0.1**
SSB, concentrate	kcal	**−12.1**	**−14.5**	**−9.8**	**−22.0**	**−26.2**	**−17.7**	**−5.4**	**−7.1**	**−3.6**
	carbs	**−2.9**	**−3.4**	**−2.3**	**−5.2**	**−6.2**	**−4.2**	**−1.3**	**−1.7**	**−0.9**
	sugar	**−2.8**	**−3.3**	**−2.3**	**−5.1**	**−6.1**	**−4.1**	**−1.2**	**−1.6**	**−0.8**
	sodium	**−9.3**	**−11.1**	**−7.5**	**−16.9**	**−20.2**	**−13.7**	**−4.1**	**−5.5**	**−2.8**
	fats	**0.0**			**0.0**			**0.0**		
	sat. fats	**0.0**			**0.0**			**0.0**		
	protein	**−0.5**	**−0.6**	**−0.4**	**−0.9**	**−1.1**	**−0.7**	**−0.2**	**−0.3**	**−0.2**
Water, coffee and tea	kcal	0.0	−0.1	0.1	0.0	−0.1	0.1	0.1	0.0	0.2
	carbs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	sugar	0.0			0.0			0.0		
	sodium	0.0	−0.2	0.3	0.0	−0.4	0.4	0.3	−0.1	0.6
	fats	0.0			0.0			0.0		
	sat. fats	0.0			0.0			0.0		
	protein	0.0			0.0			0.0		
Milk	kcal	0.2	−1.5	1.9	0.0	−3.0	3.1	**3.5**	**1.3**	**5.6**
	carbs	0.0	−0.2	0.2	0.0	−0.3	0.3	**0.4**	**0.1**	**0.6**
	sugar	0.0	−0.1	0.2	0.0	−0.3	0.3	**0.4**	**0.1**	**0.6**
	sodium	0.3	−1.8	2.4	0.0	−3.8	3.9	**4.4**	**1.7**	**7.1**
	fats	0.0	0.0	0.1	0.0	−0.1	0.1	**0.1**	**0.0**	**0.2**
	sat. fats	0.0	0.0	0.0	0.0	−0.1	0.1	**0.1**	**0.0**	**0.1**
	protein	0.0	−0.1	0.1	0.0	−0.2	0.2	**0.2**	**0.1**	**0.4**

Note: significant values to 95% in bold.

Highlights

- We estimated a demand system for foods and beverages in Chile.
- Demand for junk foods and sugar-sweetened beverages are price-elastic.
- We simulated the effect of three tax schemes on nutrient purchases.
- Tax on marketing controlled foods and drinks reduces unhealthy nutrients the most.

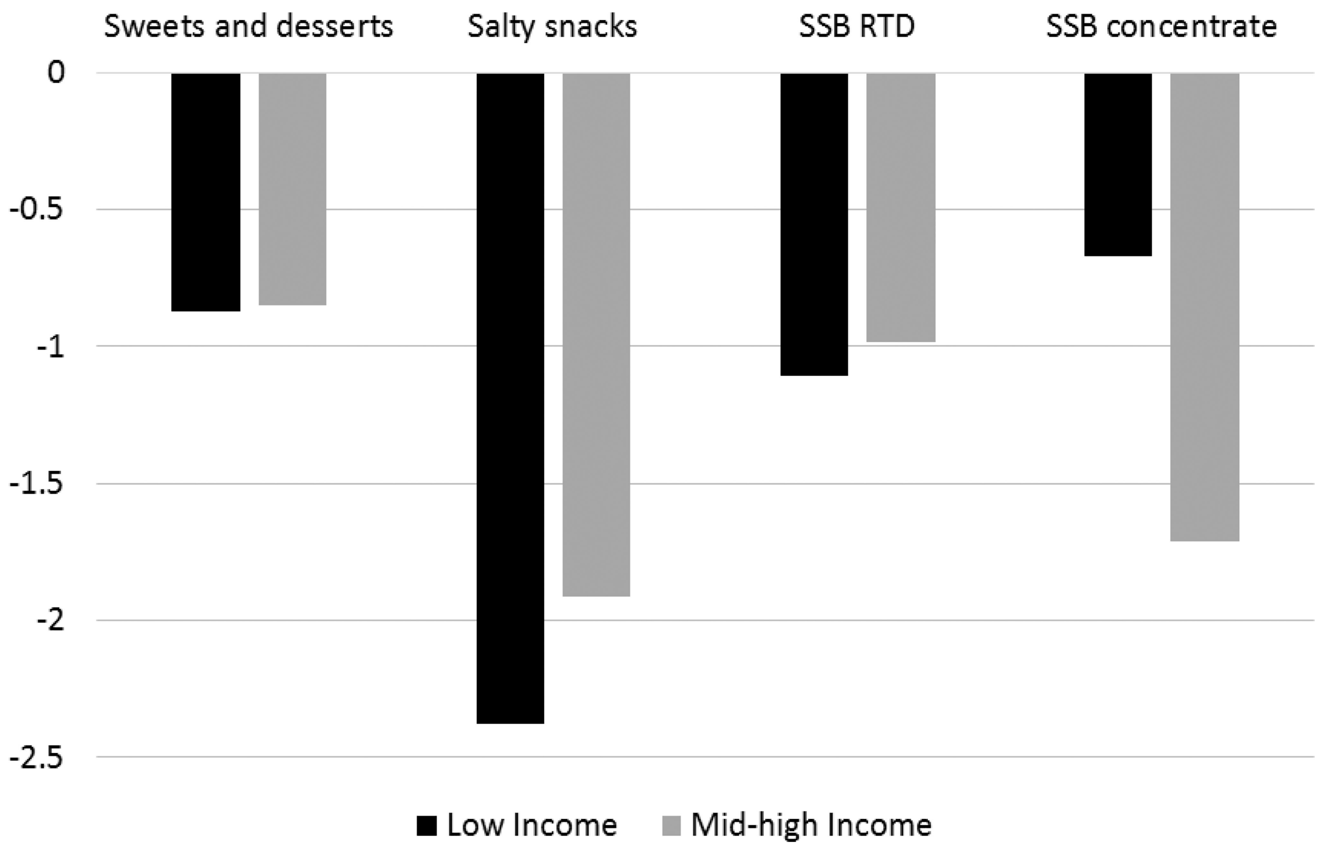

Figure 1.

Own-price elasticities by socioeconomic group

Source: Chilean Income and Expenditure Survey 2011–2012. Results based on QUAIDS restricted model adjusted for censored data.

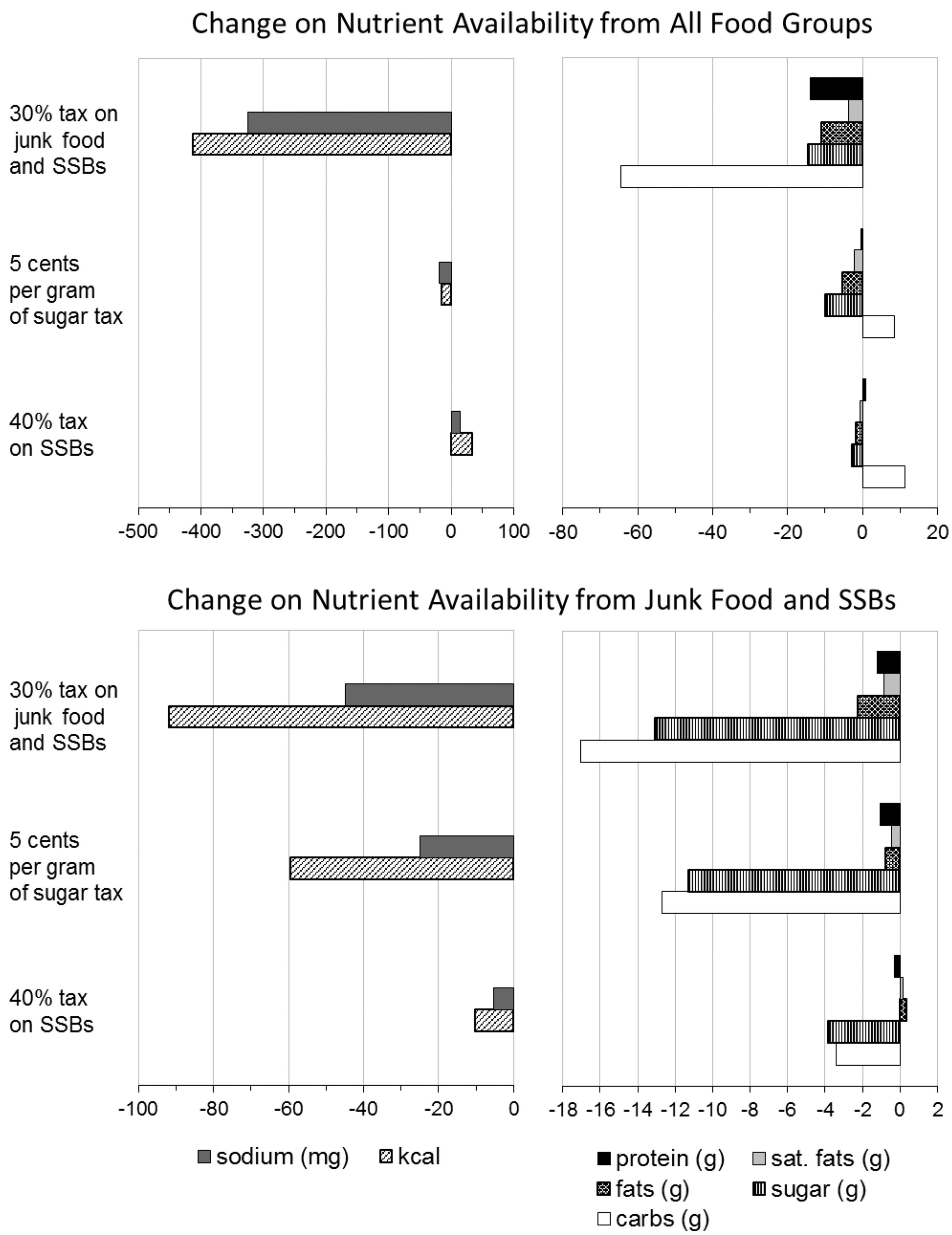

Figure 2.

Tax simulation results

Source: Chilean Income and Expenditure Survey 2011–2012. Results based on QUAIDS restricted model adjusted for censored data.

Table 1

Household sociodemographics: 10,462 households

	Low Income (4,697 obs.)			Mid-High income (5,786 obs.)			Total Sample		
Variable	**mean**	**95% CI**		**mean**	**95% CI**		**mean**	**95% CI**	
Gender of household head (0=female)	**0.51**	0.49	0.52	**0.66**	0.65	0.67	**0.59**	0.58	0.60
Age of household head (years)	**51.5**	51.0	52.0	**51.3**	50.9	51.6	**51.4**	51.1	51.7
Education of household head (years)	**9.7**	9.6	9.8	**12.9**	12.8	13.0	**11.4**	11.4	11.5
Household size (equivalent adults)	**2.8**	2.7	2.8	**3.4**	3.4	3.5	**3.2**	3.1	3.2
Region (0=main capital)	**0.43**	0.41	0.44	**0.40**	0.39	0.41	**0.41**	0.40	0.42

Table 2

Expenditure statistics on EPF survey: 10,462 households

	Expenditure and purchases (g. or ml.)			
Item	**median expenditure share**	**Median quantity purchased per capita (all households)**	**Households with expenditure > 0 (%)**	**Median quantity purchased per capita (households with exp. >0)**
Sweets and desserts	0.15	75	92.5%	105.1
Salty snacks and chips	0.03	3	33.8%	5.7
Meat products and fats	0.33	144	97.6%	175.1
F+V and seafood	0.19	257	95.1%	321.4
Cereal and cereal products	0.21	270	99.1%	310.6
SSB, ready to drink	0.10	164	85.2%	228.1
SSB, concentrate	0.02	147	35.4%	219.4
Water, coffee and tea	0.03	273	49.1%	555.6
Milk	0.06	60	59.5%	98.2

	Unit values per kilogram or liter (2011 CLP, 500 CLP = 1 USD)			
Item	mean	median	*95% conf. Interval*	
Sweets and desserts	4274.0	3,627.5	*4220.4*	*4327.6*
Salty snacks and chips	8771.9	8,102.6	*8716.0*	*8827.7*
Meat products and fats	3487.9	3,324.7	*3467.9*	*3507.9*
F+V and seafood	1285.6	1,116.6	*1272.7*	*1298.6*
Cereal and cereal products	1016.6	944.6	*1009.5*	*1023.7*
SSB, ready to drink	791.3	690.4	*782.4*	*800.1*
SSB, concentrate	142.7	141.3	*142.3*	*143.0*
Water, coffee and tea	425.7	235.2	*413.9*	*437.5*
Milk	752.6	709.8	*747.7*	*757.5*

Note: F+V: fruits and vegetables, CLP: Chilean peso.

Table 3

Uncompensated elasticities from QUAIDS model (restricted, controlling for censored data)

	Change in price								
Change in quantity	**Sweets and desserts**	**Salty snacks and chips**	**Meat products and fats**	**F+V and seafood**	**Cereals and cereal products**	**SSB, ready to drink**	**SSB, concentrate**	**Water, coffee and tea**	**Milk**
Sweets and desserts	−0.802***	−0.025	−0.229***	−0.078***	0.211***	0.07*	0.108	−0.062	−0.125**
	0.02	0.08	0.01	0.02	0.01	0.03	0.06	0.06	0.04
Salty snacks and chips	0.054**	−1.99***	−0.16***	−0.08***	0.328***	−0.033	0.261**	0.10*	0.127**
	0.02	0.14	0.01	0.02	0.01	0.03	0.10	0.05	0.05
Meat products and fats	−0.117***	−0.26*	−1.13***	0.052*	0.313***	−0.20***	−0.097	0.066	0.235***
	0.02	0.12	0.02	0.02	0.02	0.04	0.10	0.07	0.06
F+V and seafood	0.053*	−0.097	−0.08***	−1.10***	0.19***	−0.019	0.163*	0.120*	−0.077
	0.02	0.09	0.01	0.02	0.02	0.03	0.08	0.06	0.06
Cereals and cereal products	−0.009	−0.99***	−0.161***	−0.237***	−0.671***	−0.0247	0.326***	0.10*	0.513***
	0.03	0.14	0.02	0.02	0.01	0.04	0.10	0.05	0.06
SSB, ready to drink	0.099***	−0.34***	−0.21***	−0.075***	0.323***	−1.06***	0.194***	0.280***	0.136*
	0.02	0.09	0.01	0.02	0.02	0.04	0.08	0.06	0.05
SSB, concentrate	0.032*	−0.045	−0.168***	−0.086***	0.323***	−0.0006	−1.268***	0.0204	0.005
	0.02	0.09	0.01	0.02	0.01	0.03	0.13	0.05	0.04
Water, coffee and tea	0.026	−0.061	−0.160***	−0.076***	0.305***	0.048	0.07	−1.37***	0.061
	0.02	0.07	0.01	0.02	0.01	0.03	0.05	0.05	0.04
Milk	0.012	0.151	−0.141***	−0.103***	0.384***	0.043	0.131	0.141**	−1.923***
	0.02	0.10	0.01	0.02	0.01	0.03	0.09	0.05	0.06

p<0.05* p<0.01** p<0.001***

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Table 4.1

Tax simulation results for nutrient availability

	40% tax SSBs				*5 cents per gram of sugar*				*30% tax junk food and SSBs*			
	total var.	***%***	***JF var.***	***%***	**total var.**	***%***	***JF var.***	***%***	**total var.**	***%***	***JF var.***	***%***
Kcal	36.20	*2%*	−9.65	*−1%*	−22.69	*−1%*	−63.60	*−4%*	−382.45	*−23%*	−91.55	*−6%*
Carbs	11.38	*5%*	−3.39	*−2%*	8.65	*4%*	−12.69	*−6%*	−64.37	*−29%*	−17.06	*−8%*
Sugar	−2.75	*−4%*	−3.66	*−6%*	−10.44	*−16%*	−11.70	*−18%*	−14.54	*−22%*	−13.15	*−20%*
sodium	16.69	*1%*	−5.24	*0%*	−24.03	*−2%*	−26.50	*−2%*	−301.85	*−25%*	−44.07	*−4%*
Fats	−1.62	*−3%*	0.35	*1%*	−5.66	*−11%*	−0.89	*−2%*	−10.91	*−22%*	−2.20	*−4%*
saturated fats	−0.56	*−3%*	0.15	*1%*	−2.16	*−13%*	−0.48	*−3%*	−3.57	*−22%*	−0.84	*−5%*
protein	0.91	*1%*	−0.26	*0%*	−0.68	*−1%*	−1.07	*−2%*	−12.95	*−21%*	−1.18	*−2%*

Note: UI: Unhealthy Items: junk food and SSBs. Variation as percentage (%) is reported based on the median availability by purchases.

Table 4.2

Tax simulation results for nutrient availability by food group

		40% tax on SSBs			*5 cents per gram of sugar*			*30% tax on junk food*		
		mean	**95% CI**		**mean**	**95% CI**		**mean**	**95% CI**	
Sweets and desserts	kcal	10.6	2.7	18.5	−33.0	−46.9	−19.0	−56.9	−69.5	−44.3
	carbs	1.9	0.5	3.3	−5.9	−8.4	−3.4	−10.2	−12.4	−7.9
	sugar	1.4	0.4	2.5	−4.5	−6.4	−2.6	−7.7	−9.4	−6.0
	sodium	3.8	1.0	6.7	−11.9	−16.9	−6.8	−20.5	−25.0	−16.0
	fats	0.3	0.1	0.5	−0.9	−1.3	−0.5	−1.5	−1.9	−1.2
	sat. fats	0.1	0.0	0.2	−0.4	−0.6	−0.3	−0.8	−0.9	−0.6
	protein	0.1	0.0	0.2	−0.4	−0.6	−0.2	−0.7	−0.8	−0.5
Salty snacks and chips	kcal	1.3	0.2	2.4	2.3	0.3	4.3	−12.5	−14.2	−10.9
	carbs	0.1	0.0	0.3	0.2	0.0	0.5	−1.4	−1.6	−1.2
	sugar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	sodium	1.4	0.2	2.7	2.6	0.3	4.8	−14.2	−16.1	−12.3
	fats	0.1	0.0	0.1	0.1	0.0	0.2	−0.7	−0.8	−0.6
	sat. fats	0.0	0.0	0.0	0.0	0.0	0.0	−0.1	−0.1	−0.1
	protein	0.0	0.0	0.0	0.0	0.0	0.1	−0.1	−0.2	−0.1
Meat products and fats	kcal	−35.2	−59.0	−11.4	−69.9	−112.2	−27.5	−75.5	−111.7	−39.4
	carbs	−0.1	−0.2	0.0	−0.2	−0.3	−0.1	−0.2	−0.3	−0.1
	sugar	−0.1	−0.1	0.0	−0.1	−0.2	0.0	−0.1	−0.2	−0.1
	sodium	−42.0	−70.5	−13.6	−83.5	−134.0	−32.9	−90.3	−133.5	−47.0
	fats	−3.0	−5.1	−1.0	−6.0	−9.6	−2.4	−6.5	−9.6	−3.4
	sat. fats	−1.0	−1.7	−0.3	−2.0	−3.2	−0.8	−2.2	−3.2	−1.1
	protein	−1.9	−3.2	−0.6	−3.7	−6.0	−1.5	−4.0	−6.0	−2.1
F+V and seafood	kcal	6.6	−0.6	13.8	10.7	−2.0	23.5	−2.9	−14.0	8.1
	carbs	1.1	−0.1	2.2	1.7	−0.3	3.8	−0.5	−2.2	1.3
	sugar	0.4	0.0	0.9	0.7	−0.1	1.6	−0.2	−0.9	0.5
	sodium	4.7	−0.4	9.8	7.6	−1.4	16.6	−2.1	−9.9	5.7

		40% tax on SSBs			5 cents per gram of sugar			30% tax on junk food		
		mean	95% CI		mean	95% CI		mean	95% CI	
	fats	0.2	0.0	0.4	0.3	−0.1	0.6	−0.1	−0.4	0.2
	sat. fats	0.0	0.0	0.1	0.0	0.0	0.1	0.0	−0.1	0.0
	protein	0.3	0.0	0.7	0.5	−0.1	1.2	−0.1	−0.7	0.4
Cereal and cereal products	kcal	71.1	37.0	105.2	102.2	41.6	162.8	−243.1	−306.1	−180.2
	carbs	13.6	7.1	20.2	19.6	8.0	31.2	−46.7	−58.7	−34.6
	sugar	0.4	0.2	0.6	0.5	0.2	0.9	−1.3	−1.6	−1.0
	sodium	55.1	28.7	81.5	79.3	32.3	126.2	−188.5	−237.4	−139.7
	fats	0.7	0.3	1.0	1.0	0.4	1.5	−2.3	−2.9	−1.7
	sat. fats	0.2	0.1	0.3	0.3	0.1	0.4	−0.6	−0.7	−0.4
	protein	2.5	1.3	3.7	3.6	1.5	5.8	−8.6	−10.9	−6.4
SSB, ready to drink	kcal	−15.1	−17.7	−12.5	−15.8	−20.5	−11.2	−17.0	−20.9	−13.1
	carbs	−3.8	−4.4	−3.1	−3.9	−5.1	−2.8	−4.2	−5.2	−3.3
	sugar	−3.6	−4.3	−3.0	−3.8	−4.9	−2.7	−4.1	−5.0	−3.2
	sodium	−5.2	−6.2	−4.3	−5.5	−7.1	−3.9	−5.9	−7.3	−4.6
	fats	0.0			0.0			0.0		
	sat. fats	0.0			0.0			0.0		
	protein	−0.1	−0.1	−0.1	−0.1	−0.2	−0.1	−0.1	−0.2	−0.1
SSB, concentrate	kcal	−7.1	−8.6	−5.5	−13.1	−15.8	−10.4	−5.5	−6.8	−4.1
	carbs	−1.7	−2.0	−1.3	−3.1	−3.8	−2.5	−1.3	−1.6	−1.0
	sugar	−1.6	−2.0	−1.3	−3.0	−3.6	−2.4	−1.3	−1.6	−1.0
	sodium	−5.4	−6.6	−4.3	−10.1	−12.2	−8.0	−4.2	−5.2	−3.2
	fats	0.0			0.0			0.0		
	sat. fats	0.0			0.0			0.0		
	protein	−0.3	−0.4	−0.2	−0.5	−0.7	−0.4	−0.2	−0.3	−0.2
Water, coffee and tea	kcal	0.1	0.0	0.1	0.1	0.0	0.2	0.0	−0.1	0.0
	carbs	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
	sugar	0.0			0.0			0.0		
	sodium	0.3	0.1	0.4	0.3	0.0	0.7	−0.1	−0.4	0.2

		40% tax on SSBs			5 cents per gram of sugar			30% tax on junk food		
		mean	**95% CI**		**mean**	**95% CI**		**mean**	**95% CI**	
	fats	**0.0**			**0.0**			0.0		
	sat. fats	**0.0**			**0.0**			0.0		
	protein	**0.0**			**0.0**			0.0		
Milk	kcal	**1.4**	***0.0***	***2.7***	1.7	*−0.8*	*4.1*	0.6	*−1.3*	*2.5*
	carbs	***0.2***	***0.0***	**0.3**	*0.2*	*−0.1*	0.4	*0.1*	*−0.1*	0.3
	sugar	**0.1**	***0.0***	***0.3***	0.2	*−0.1*	*0.4*	0.1	*−0.1*	*0.3*
	sodium	**1.7**	***0.0***	***3.4***	2.1	*−0.9*	*5.1*	0.8	*−1.6*	*3.1*
	fats	**0.0**	***0.0***	***0.1***	0.1	*0.0*	*0.1*	0.0	*0.0*	*0.1*
	sat. fats	**0.0**	***0.0***	***0.1***	0.0	*0.0*	*0.1*	0.0	*0.0*	*0.1*
	protein	**0.1**	***0.0***	***0.2***	0.1	*0.0*	*0.3*	0.0	*−0.1*	*0.2*

Note: significant values to 95% in bold.

Table 5

Own-price uncompensated elasticities comparison (demand system models)

Study	Data	Junk Food	SSBs	Notes
(Heien & Wessells, 1990)	US households	−2.19 to −0.05	−1.38 to −1.10	SSBs. Junk Food: Ice cream
(Huang & Lin, 2000)	4,245 US households		−1.01	Juices only.
(Yen, Lin, & Smallwood, 2003)	1.069 US households		−1.03	SSBs
(Pittman, 2004) *	5,715 US households		−1.07 to −0.86	SSBs
(Chouinard, Davis, LaFrance, & Perloff, 2005)	US households	−0.80 to −0.77		Junk food: ice cream, flavored yogurt
(Smith, Lin, & Lee, 2010)	US households		−1.26	SSBs
(Allais, Bertail, & Nichele, 2010)	5,000 FR households	−0.47 to −0.39	−0.99 to −0.98	Sodas only. Junk food: sugar and fat products
(Zhen, Wohlgenant, Karns, & Kaufman, 2011)	33,206 US households		−1.06	Sodas only, low income households
(Bonnet & Requillart, 2011)	19,000 FR households		−4.2 to 2.92	Different brands of soda drinks.
(Dharmasena, Davis, & Capps, 2011)	US households		−2.26 to −1.17	SSBs
(Gustavsen & Rickertsen, 2011)	25,023 Norway households	−2.58 to −0.99	−1.73 to −0.85	SSBs. Junk Food: Candy and ice cream
(Kotakorpi, Harkanen, & P., 2011) *	17,000 Finish households	−2.54		Junk Food: sugar and sweets
(Lin, Smith, Lee, & Hall, 2011)	22,750 US households		−0.95	SSBs
(Bonnet & Requillart, 2012) *	19,000 FR households		−4.9 to −2.37	Different brands of soda drinks.
(Briggs et al., 2013)	5,263 UK households		−0.81	SSB ready-to-drink
(Sharma, Hauck, Hollingsworth, & Siciliani, 2014)	5,560 AUS households		−0.63	Sodas only
(Zhen et al., 2014)	37,786 US households	−1.67 to −1.11	−1.04	Junk food: ice cream, candy, cakes, snacks
(Colchero et al., 2015)	73,311 MEX households	−0.98 to −1.15	−1.16	Junk food: candy and snacks
(Harding & Lovenheim, 2014) *	162,974 US households	−0.29 to −0.27	−2.26 to −2.19	Sodas only. Junk food: candy and snacks
(Paraje, 2016)	39,617 EQ households		−1.2	SSBs

* Not peer-reviewed