Food Policy 71 (2017) 86–100

Contents lists available at ScienceDirect

Food Policy

journal homepage: www.elsevier.com/locate/foodpol

Designing a tax to discourage unhealthy food and beverage purchases: The case of Chile

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ARTICLE INFO

Keywords:
Price elasticity
Food tax options
Junk food tax
SSB tax
Nutrient tradeoffs
Almost ideal demand system

JEL classification:
D12
H20
H31
I12

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 non-communicable diseases (NCDs), causing significant costs to societies and individuals. 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 policies 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 from Chile. We take into account the high proportion of households not purchasing various food and beverage groups (censored nature of data) and endogeneity on total expenditures. The food groups considered were: sweets and desserts; salty snacks and chips; meat products and fats; fruits, vegetables and seafood; grain-based staples; ready-to-drink SSB; SSB from concentrate; plain water, coffee and tea; and milk, which together represent 90% of food expenditures. The simulated taxes were: (1) 18% price tax on all foods and beverages exceeding thresholds on sodium, saturated fat, and added sugar and for which marketing is restricted (based on a Chilean law, effective June 16, 2016); (2) 40% tax on SSBs (22% above the current tax level); and (3) a 1 Chilean peso (0.2 US cents) per gram of sugar tax on products with added sugar. Unhealthy beverages and foods are price-elastic (-1.95 for salty snacks and chips, -1.30 for ready-to-drink SSBs, 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 foods and beverages high in fat, salt and sugar 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 labelling of unhealthy foods and beverages. The design of a more comprehensive tax to enhance the overall effect of these policies on healthier diets is a next critical step. This study shows that a tax on the same foods and beverages already delineated as unhealthy by the marketing controls and front-of-pack labelling should promote a healthier diet.

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 et al., 2015; Kwan et al., 2016; Malik et al., 2013; Murray et al., 2012; Withrow and 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 (Corvalán et al., 2013; Camila Corvalán et al., 2010, 2009). These findings are consistent with the global consensus that links SSBs and energy dense ultra-processed foods as leading risk factors associated

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http://dx.doi.org/10.1016/j.foodpol.2017.08.001
Received 6 July 2016; Received in revised form 12 July 2017; Accepted 2 August 2017

with obesity and overweight (Malik et al., 2010; Morenga et al., 2013; Tavares et al., 2012). In 2014, Chile led total SSBs consumption per capita per day worldwide, with the highest growth rate in the 2009–2014 period (Popkin and Hawkes, 2016). SSBs expenditure in Chilean households rose 151% between 1987 and 2007, to 289 ml per capita per day (M. M. Crovetto and 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 (Crovetto et al., 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 and Techakehakij, 2012; Sacks et al., 2011; Thow et al., 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 et al., 2016; Biro, 2015; Colchero et al., 2016; Smed et al., 2016; Snowdon and Thow, 2013). In Chile, starting in September 2014, the tax rate for SSBs with sugar content higher than 15 g 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, as well as those high in fat, salt and sugar (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 (Colchero et al., 2016), Hungary (Biro, 2015) and Denmark (Jensen et al., 2015). Work by others have estimated 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 discourage unhealthy nutrient intakes (Nnoaham et al., 2009; Smed et al., 2007), but this has yet to be done for Chile or other rapid growth countries. 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' response to prices by stockpiling or adjusting quality of purchases, 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) by accounting for censoring as well as endogeneity in expenditures, 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 cross-sectional VII Income and Expenditure Survey (EPS, Spanish acronym) collected between 2011 and 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 and Muellbauer, 1980), introduced by (Banks et al., 1997), QUAIDS for short, which allows more flexibility over the income-expenditure (Engel) curves. The model in its budget share form is defined as follows:

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

With the nonlinear price aggregators:

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

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

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. Following earlier work (Deaton and Muellbauer, 1980), we impose constraints of 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) within the demand system of foods and beverages. In particular these constraints are:

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

When controlling for potential censored nature of the data (as further explained below), the non-linear system of equations is no longer bound to add up to unity. However, adding up and negativity constrains are imposed within the second stage. Therefore, we do not impose the restriction that $\sum_{i\in I} w_i = 1$.

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 and Yen, 1999) propose a two-step process according to a censored model. 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 Eq. (1) as follows:

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