Deliverable 4.1

Sugar-sweetened beverages taxation and reformulation: A structural model to assess impacts and industry responses.

UCSC partner
Daniele Moro, Livia Bartolomei, Stefano Boccaletti, Mirta Casati, Elena Castellari, Giulia Tiboldo

March 2026

Sugar-sweetened beverages taxation and reformulation: A structural model to assess impacts and industry responses.

General background

Given the well-documented health risks associated with excessive consumption of sugar-sweetened beverages (SSBs), taxation on these products has been increasingly advocated as an effective policy measure to combat rising obesity rates and prevent diet-related non-communicable diseases (NCDs) (Bonnet and Réquillart 2013b; Andreyeva et al. 2022; Jones-Smith et al. 2022; Le Bodo et al. 2022; Thow et al. 2022). The World Health Organization (WHO) has also endorsed SSB taxation as a strategy to reduce sugary drink purchases and overall sugar intake, encourage product reformulation, and generate revenue (WHO 2015; 2017).

Over the past decades, numerous European countries have implemented sugar-sweetened beverage (SSB) taxes in various forms. Examples include Norway (2009), Finland (2011), France (2012), Belgium (2015), Portugal (2017), Ireland (2018), the United Kingdom (2018), Croatia (2020), Poland (2021), and Hungary and Latvia (2022), with differences in tax structure - whether based on volume or sugar content - tax rates (flat or tiered depending on sugar levels), and tax base (e.g., exemptions for fruit juices in some cases) (Cornelsen & Smith, 2018). In Italy, the sugar tax was introduced by the 2020 Budget Law (D.L. 27.12.2019, n.160) but has faced multiple delays, with its enforcement now scheduled for January 1, 2027 (D.L. 23.05.2024, n.67). The tax is designed as a volumetric excise duty on SSB manufacturers, imposing a flat rate of €0.10 per Liter on finished products containing added caloric sweeteners, provided their sugar content exceeds 25 grams per Liter (D.L. 27.12.2019, n.160).

As SSB taxation has become a key element of nutrition policies in many countries, its impact remains a subject of debate, with mixed findings in the literature (e.g., Andreyeva et al. 2011; Bonnet and Réquillart 2013b; Cawley and Frisvold 2017; Capacci et al., 2019; Rojas and Wang 2021; Andreyeva et al. 2022). This has fueled growing interest in ex-ante evaluations of such policies, including the Italian sugar tax (Bonnet and Réquillart 2013b; Jones-Smith et al. 2022; Tiboldo et al. 2024).

Discussion often emphasizes the negative health effects of excessive sugar consumption (both in terms of internalities and externalities) and the potential benefits of using tax revenues for health initiatives. On the contrary, economic concerns arise, such as potential job losses and the regressive impact on lower-income populations, although lower income strata are also more responsive to price changes. Also, studies suggest that media coverage and public awareness campaigns can influence consumer behaviour, sometimes more than the price change alone. Further, tax salience - whether the tax is clearly displayed on price tags or receipts – seems to play a role: research indicates that consumers are more responsive when taxes are included in the posted price rather than added at checkout. This seems to confirm the 'signalling' content of the tax (Capacci et al. 2019), versus potentially adverse health effects of SSBs consumption. Finally, a somewhat related issue is the effect on SSBs purchases and sugar intake of the announcement of the introduction of a tax (Rogers et al. 2024).

SSBs taxes sometime uses tiered tax rates based on the sugar content of beverages. The goal is then also to encourage manufacturers to remove added sugars, promote lower-sugar alternatives, and reduce portion sizes, rather than merely cutting soda purchases. This approach may shift market dynamics, in favour of mid-range products taxed at a lower rate. Additionally, there is uncertainty about whether the tax will be fully passed on to consumers since it is levied on producers, who may use varied pricing strategies across their product lines. Evaluating the economic impact of these multi-tiered, producer-targeted taxes requires considering various scenarios, including product reformulation, price adjustments for both taxed and untaxed products, and broader economic redistributive effects.

For an ex-ante evaluation of consumers' response under strategic pricing by firms, a well-known approach is that of building on a structural econometric model. Following Bonnet and Requillart (2011; 2013a; 2013b), the econometric models require first, to estimate consumers' demand on SSBs using the random coefficient logit demand model (Berry et al. 1995), allowing for substitution patterns across differentiated products. Second, for the supply side, demand estimates are used to recover marginal costs for each product in the market, assuming the existence of a Nash-Bertrand price equilibrium, fixed retailer markups and constant marginal costs. The estimated demand parameters and marginal costs can be used to conduct a counterfactual simulation to derive the new markets' equilibria (i.e., SSBs prices, market share and households' consumption patterns) and the welfare effects. This approach has been applied on Nielsen Household Panel data on SSBs purchases in Italy for the period January 2019 - December 2020; demand parameters' estimates and marginal costs have been used to conduct a counterfactual simulation of the effects (on markets and welfare) of the introduction of different SSBs tax scheme in Italy (Tiboldo et al. 2024).

Companies respond to SSBs taxes by adapting their marketing 4P's, that is product, placement, promotion and pricing (Forde et al., 2023). Product reformulation is one of the possible strategies. *Food reformulation is the process of altering the processing or composition of a food or beverage product, to improve its nutritional profile or to reduce its content of ingredients or nutrients of concern* (WHO, 2022). Reformulation allows us to meet public health goals, limiting the intake of unhealthy nutrients and therefore improving the nutritional profile of individuals' diets, but also can be a business strategy to reposition brands and create business opportunities, by targeting new market segments; further, it may complement pricing strategies, avoiding taxation of unhealthy nutrients, as is the case of SSBs. In fact, in the UK between 2015 and 2019, approximately 65% of beverages containing more than 5 g of sugar per 100 ml were reformulated to fall below this threshold (the share of beverages exceeding the 5 g of sugar per 100 ml threshold declined markedly, falling from an expected level of approximately 49% to around 15%). As a result, the share of low-sugar beverages (i.e., containing less than 5 g of sugar per 100 ml) increased substantially, reaching around 89% of the market, and the average sugar content of soft drinks declined by up to 47% between 2015 and 2024 (Scarborough et al. 2020; UK Government 2025). Also, empirical evidence indicates that major brands are more willing to reformulate.

The Model: theoretical and empirical issues

The demand side

The starting point is to model the demand for SSBs. We rely on the random coefficients logit demand model developed by Berry, Levinsohn, and Pakes (1995) (herein BLP). This model solves the dimensionality issue of differentiated markets by projecting the products into the characteristics space and represents consumer preference as a function of product attributes and consumer characteristics (Nevo 2000; Kim 2004). Moreover, it allows to obtain more flexible substitution patterns with respect to the standard multinomial logit (Bonnet and Requillart 2011; Bonnet and Requillart 2013; Villas-Boas 2007). Following Tiboldo, Castellari & Moro (2024), the indirect utility that each consumer *i* gets from the consumption of product *j* in market *m* is a function of its price (p_{jm}), the observed and unobserved (by the econometrician) product characteristics (X_{jm}, ξ_{jm}), and the unknown parameters of the model, (α_i, β):

$$U_{ijm} = \alpha_i p_{jm} + \beta X_{jm} + \xi_{jm} + \varepsilon_{ijm} \quad (1)$$

where ε_{ijm} is a mean zero stochastic term that is assumed to be independently and identically distributed (*i.i.d*) with an extreme value type I distribution (Berry et al. 1995; Nevo 2000; Kim 2004).

The random parameter α_i (i.e., the price coefficient) represents the marginal utility of income and accounts for the potential heterogeneity of individual preferences for price (Kim, 2004). Following Nevo (2000), the distribution of consumers' taste parameter for price is modelled as follows:

$$\alpha_i = \alpha + \sigma v_i + \pi D_i \qquad v_i \sim P_v(v), D_i \sim P_D^* \tag{2}$$

where α represents the mean preference for price and is common to all consumers, v_i is a vector of unobserved (to the econometrician) demographic characteristics that follows a known parametric distribution $P_v(v)$, σ is the associated parameter measuring the unobserved heterogeneity of consumers, D_i includes observable demographic characteristics, π is the vector of associated parameters measuring how the taste parameter varies with the demographics, and P_D^* might be a non-parametric distribution known from other sources, or a parametric distribution with the parameters estimated somewhere else. For simplicity, we assume $P_v(v)$ has a standard normal distribution.

Therefore, the utility that consumer *i* can get from product *j*, as in (2), can be divided into two parts: a mean utility component, δ_j, which is product-specific and common to all households, and a mean-zero heteroskedastic deviation from the mean, $u_{ijm}+\varepsilon_{ijm}$, which captures the effect of the random coefficients:

$$U_{ijm} = \delta_{jm} + u_{ijm} + \varepsilon_{ijm} \tag{3}$$

where:

$$\delta_{ijm} = \alpha p_{jm} + \beta X_{jm} + \xi_{jm} \tag{4}$$

$$u_{ijm} = \sigma v_i p_{jm} + \pi D_i p_{jm} \tag{5}$$

We complete the consumer choice model by allowing an outside good to account for the possibility that consumers do not buy any of the products included in the choice set (i.e., no consumption). For the outside good, we normalize the mean utility (δ_0) to zero. Without the outside good, a homogenous price increase of all the products would result in no changes in quantities purchased for the inside option (Nevo 2000; Kim 2004).

The model further assumes that each consumer buys only one unit of the good that provides him/her with the highest utility and that ties do not occur. As ε_{ijm} is assumed to be independently and identically distributed (*i.i.d.*) like a type I extreme value distribution, the probability that consumer *i* purchases product *j* in market *m,* s_{ijm}, is computed as follows (Nevo 2000; Kim 2004) :

$$s_{ijm} = \frac{\exp\left(\delta_{jm} + u_{ijm}\left(\nu, D\right)\right)}{1 + \sum_{r=1}^{J}\left(\delta_{rm} + u_{irm}\left(\nu, D\right)\right)} \qquad (6)$$

Aggregating (6) over all consumers in the market, we can interpret such probabilities as the market shares of each product j in the market, so that we obtain market demand in share form, s_{jm}:

$$s_{jm} = \int s_{ijm} dP_{\nu}\left(\nu\right) dP_{D}\left(D\right) = \int \frac{\exp\left(\delta_{jm} + u_{ijm}\left(\nu, D\right)\right)}{1 + \sum_{r=1}^{J}\left(\delta_{rm} + u_{irm}\left(\nu, D\right)\right)} dP_{\nu}\left(\nu\right) dP_{D}\left(D\right) \qquad (7)$$

As the integral in (7) does not have an analytic closed form solution, it can be approximated through a simulation estimator that replaces the population density with the empirical distribution obtained from *ns* random draws (Berry, Levinsohn, and Pakes, 1995):

$$s_{jm} = \frac{1}{ns}\sum_{i=1}^{n} \Pr_{ijm} = \frac{1}{ns}\sum_{i=1}^{n} \frac{\exp\left(\delta_{jm} + u_{ijm}\left(\nu, D\right)\right)}{1 + \sum_{r=1}^{J}\left(\delta_{rm} + u_{irm}\left(\nu, D\right)\right)} \qquad (8)$$

The estimated parameters from equation (7) can then be used to estimate numerically own- and cross-price elasticities of demand for each product as follows:

$$\eta_{jkm} = \frac{\partial s_{jm}}{\partial p_{km}} \frac{p_{km}}{s_{jm}} = \begin{cases} \frac{p_{jm}}{s_{jm}} \int \alpha_i s_{ijm}\left(1 - s_{ijm}\right) dP_{\nu}\left(\nu\right) dP_{D}\left(D\right) & \text{if } j = k \\ -\frac{p_{km}}{s_{jm}} \int \alpha_i s_{ijm}\left(1 - s_{ijm}\right) dP_{\nu}\left(\nu\right) dP_{D}\left(D\right) & \text{if } j \neq k \end{cases} \qquad (9)$$

where each individual *i* has a different price sensitivity for every product in the choice set.

The supply side and the market equilibrium

Following Berry et al. (1995) and Nevo (2001), we assume that the profit of each multiproduct firm *f* that produces a subset J_f of the *J* products in the market is defined as:

$$\Pi_f = \sum_{j \in J_f}\left(p_j - c_j\right) M s_j\left(p, X, \xi; \theta\right) - C_f \qquad (10)$$

where p_j and c_j are the price and marginal cost of product *j*, respectively; *M* is the market size; s_j is the market share of product *j*; θ includes the estimated demand parameters; and C_f are the fixed costs of production.

Under the assumption of a pure-strategy Nash-Bertrand equilibrium, firms simultaneously choose prices to maximize profits from all the J_f products, yielding the following first order conditions:

$$\frac{\partial \Pi_f}{\partial p_j} = s_j(\bullet) + \sum_{r \in J_f} (p_r - c_r) \frac{\partial s_r(\bullet)}{\partial p_j} = 0 \qquad \textit{for all } j \in J_f \tag{11}$$

which can be re-written in matrix form:

$$s(\bullet) - \Omega(p)\Lambda(p-c) = 0 \tag{12}$$

where $\Omega(p)$ is the matrix of partial derivatives of the market shares with respect to prices, and Λ is the market structure matrix, whose elements are defined as follows (Berry et al., 1995):

$$\Omega_{rj}(p) = -\frac{\partial s_r(\bullet)}{\partial p_j} \qquad \textit{for each } j, r \in J_f \tag{13}$$

$$\Lambda_{rj}(p) = \begin{cases} 1 & \textit{if } j, r \in J_f \\ 0 & \textit{otherwise} \end{cases} \tag{14}$$

The price-cost margin and marginal cost for each product j can be recovered by solving the system of equations in (12):

$$(p-c) = (\Omega(p)\Lambda)^{-1} s(\bullet) \tag{15}$$

$$c = p - (\Omega(p)\Lambda)^{-1} s(\bullet) \tag{16}$$

As data about wholesale prices are not available, we assume a constant mark-up rule for the retailer. Hausman and Leonard (2002) show that retail prices and demand elasticities can be used to approximate manufacturers' first order conditions under this assumption. As explained in previous works on vertical relationship in the supply chain, such as Chidmi (2012) and Villas-Boas (2007), the price-cost margins derived from equation (15) following Berry et al. (1995) and Nevo (2001) are similar to the ones obtained in the case of a two-part tariff agreement between the retailer and the manufacturer in which the retail-price cost margin are set equal to zero. In this situation, the retail prices are given by the sum of manufacturers' wholesale prices and the retail marginal cost, while the retailers set the franchise fee *F* to extract part of the manufacturers' profits. The marginal cost computed in equation (16) can be interpreted as the total marginal cost (i.e., marginal cost of production and distribution).

Product reformulation

Following Allais et al. (2023), our initial approach considers exogenous product reformulation that will occur in the sugar content of SSBs. The degree of reformulation is of course driven by the tax scheme. In general, we expect firms to try to minimize the impact of the tax, if possible: for example, the Italian tax scheme contemplates a tax equal to 0.10 euro per Liter if the sugar content is above 25 grams per Liter; therefore, we expect reformulation to reduce the sugar content below the threshold, if technically and sensory feasible.

The assumption in simulating the reaction of firms to the tax is that firms will try to avoid the taxation the most (for example, firms with a sugar content above the tax threshold would reformulate in order to avoid the tax reducing the sugar content below the threshold), according to sensory feasibility, with different tax schemes (i.e., a tax proportional to the sugar content). Therefore, we will try to simulate reformulation as a technically and sensory feasible sugar reduction. In principle, such reformulation will not come without a cost, and therefore we expect a change in firms' marginal costs:

$$\Delta c_j = \rho_S \Delta q_{S,j} + \rho_{SW} \Delta q_{SW,j} \tag{17}$$

The change in product's marginal cost depends on the cost reduction from lessening the sugar content and the cost increase due to the use of alternative sweeteners in the product recipe.

Counterfactual simulations

The aim is to estimate the impact on prices and consumption (and therefore on sugar intake) of a tax with (see Tiboldo et al., 2024) and without reformulation. The standard approach is for firm *f* to

$$\max \Pi_f = \sum_{j \in J_f} \left(p_j - \tilde{c}_j \right) M s_j \left(p \right) - C_f \tag{18}$$

where $\tilde{c}_j$ is the new marginal cost:

$$\tilde{c}_j = c_j + \phi t + \vartheta \Delta c_j \tag{19}$$

where ϕ is equal to 1 if the product is subject to the tax 0 otherwise (see above), and t is equal to the amount of the tax, and Δc_j is the cost differential due to reformulation.

Then, the new equilibrium prices for SSBs (p_j*) can be derived by solving the following problem:

$$\min_{\{p_j^*\}} \left\| p_j^* - \lambda \left(p_j^* \right) - \tilde{c}_j \right\| \tag{20}$$

where ||.|| is the Euclidean norm in $\mathbb{R}^J$ while λ corresponds to the manufacturers' margin.

The cost pass-through rate can then be computed as the proportion of the change in the marginal cost that is transferred to final prices (Kim and Cotterill 2008; Bonnet and

Requillart 2013a), while the new equilibrium market share vector can be derived using the price elasticity values and the estimated percentage variations in SSBs prices after SSBs taxation, together with the effect of reformulating the product. In this way, we can predict the new market equilibrium, and so, the potential impact of the sugar tax on SSBs prices and consumption, and derive the distributional implications also in terms of consumers' health.

To assess the effectiveness of sugar taxes to foster reformulation, we may simulate different tax schemes. The simulated reformulation scenario will be then compared with the standard tax scenario, looking at some exogenous reformulation patterns.

Model estimation

Data

We use Nielsen Household Panel data on SSBs purchases in Italy for the period January 2019- December 2020. These data provide detailed information on beverages purchases (e.g., quantity, price, channel), product characteristics (e.g., vendor name flavor, packaging, energy, and sugar content, etc…), as well as households' characteristics (e.g., income level, household size, etc…) for over 9,000 Italian households. Products are defined based on vendor name (national brand (NB) 1 to 10 and private labels (PLs)), segment (i.e., iced tea, cola, other carbonated soft-drinks, fruit drinks) and sugar content (i.e., regular vs diet, and actual sugar content). A market is defined as a region[1]-time period combination, with a time period consisting of 4 consecutive weeks. Therefore, the market share for each product is computed as the ratio of the sum of purchases of that product for all the households in the selected market divided by the total value of beverages purchases in the relevant market.

Following previous empirical works analyzing the demand for differentiated products using the BLP approach (e.g., Nevo 2001; Lopez and Lopez 2009; Bonnet and Réquillart 2011; 2013a; 2013b; Hirsch et al. 2018; Zhang and Palma 2021), we have selected the first 25 SSBs products with the highest national market share in the period 2019-2020 (Tiboldo et al. 2024), accounting for 60% of total sales of SSBs (i.e., colas and other carbonated soft drinks, iced tea, fruits drinks and juices, flavored and enhanced water, energy drinks) and one third (32.8%) of total beverages purchases (i.e., SSBs plus bottled water sales).

[1] Even though the Italian territory consists of 20 regions, Valle d'Aosta and Piemonte and Molise and Abruzzo are considered as one region due to the data limitations.

Table 1. Summary statistics for the selected sample.

Product	Vendor	Segment	Type[1]	Share (%)	Price (€/L)	Sugar share (%)
1	NB1	Iced tea	R	0.59%	1.18	0.9%
2	NB10	Iced tea	R	0.35%	0.94	1.1%
3	NB2	Iced tea	R	3.13%	1.86	4.3%
4	NB4	Iced tea	R	1.00%	0.93	2.7%
5	PLs	Iced tea	R	0.96%	0.75	2.8%
6	NB2	Iced tea	D	0.45%	1.85	0.0%
7	NB1	Cola	R	7.49%	1.26	17.4%
8	NB3	Cola	R	2.06%	0.81	5.6%
9	PLs	Cola	R	0.43%	0.45	2.6%
10	NB1	Cola	D	3.31%	1.26	0.0%
11	NB3	Cola	D	0.43%	0.81	0.0%
12	NB1	Other soft drinks	R	1.31%	1.05	3.7%
13	NB1	Other soft drinks	R	0.40%	1.1	0.2%
14	NB4	Other soft drinks	R	0.68%	0.57	2.2%
15	NB4	Other soft drinks	R	1.12%	1.28	1.7%
16	NB5	Other soft drinks	R	0.37%	1.11	2.2%
17	NB5	Other soft drinks	R	0.80%	1.12	0.9%
18	PLs	Other soft drinks	R	1.09%	0.53	5.3%
19	NB4	Other soft drinks	D	0.47%	0.83	0.1%
20	NB9	Fruit drinks	R	1.16%	1.64	2.2%
21	NB8	Fruit drinks	R	0.62%	1.41	1.6%
22	NB7	Fruit drinks	R	0.75%	1.03	1.7%
23	PLs	Fruit drinks	R	2.33%	1.09	5.5%
24	NB6	Fruit drinks	R	0.73%	1.37	1.3%
25	NB6	Fruit drinks	D	0.83%	1.62	0.6%

Source: Authors' calculation using Nielsen Household Panel data (2019-2020).
Notes: The market share and price per litre for each product are derived using information on SSBs purchases for a nationally representative sample of Italian households (n=9,000) collected over a two-year period (2019-2020). The average market share for each product is computed as the ratio of the total value of purchases for that product over the total value of beverages purchases (i.e., SSBs plus drinking water) in the period 2019-2020. Average prices are derived as the ratio of the total sales value divided by the total volume sold for each product. The average sugar share is computed as the ratio of total sugar provided by each product over the total sugar sales in the sample. [1]R=regular; D=diet.

In Table 1 we report summary statistics. Regular products represent more than 80% of total SSBs purchases in the sample. NB1 is the market leader, holding approximately 13% of total sales in this market, that is, one third of the total sales value in the sample. Diet and regular products for each vendor have similar prices (e.g., product 3 and 6 for NB2 and product 7 and 10 for NB1). PLs products account for approximately 15% of total SSBs sales in the sample and, on average, are priced almost 50% below NBs.

To account for the differential impact of SSBs taxes across different socio-economic groups, households are grouped into six classes according to their income level and the presence of children in the household. Following the income level classification provided in the Nielsen Households Panel dataset, we distinguish three categories of income level: 1) low income (low) 2) middle income (middle); and 3) high income (high). In detail, monthly per capita income for low-income households is below 1,141 euros, while it exceeds 1,670 euros for high income households. Per capita income of middle-income households lies in between. Table 2 illustrates differences in SSBs consumption across socio-economic groups

Table 2. Average household (HH) and per capita SSBs consumption (cons.) per year by socio-economic group.

Income level	Child	% Pop	HHsize	HH SSBs cons. (litre/year)	Per capita SSBs cons. (litre/year)	% Diet/Tot
Low						
	all	51.8%	3.2	38.2	12.3	13.6%
	no	33.0%	2.5	33.0	13.2	14.2%
	yes	18.8%	3.9	43.4	11.3	13.0%
Middle						
	all	30.1%	2.9	36.8	13.2	17.4%
	no	25.3%	2.1	29.8	14.1	18.2%
	yes	4.8%	3.6	43.8	12.3	16.6%
High						
	all	18.1%	2.6	33.4	13.7	20.5%
	no	16.8%	1.7	25.1	15.2	23.4%
	yes	1.3%	3.4	41.6	12.2	17.6%

Source: Authors' calculation using Nielsen Household Panel data (2019-2020).
Notes: % Pop represents the percentage of households belonging to each socio-economic groups, while HHsize represents the average household size computed over all the households belonging to each socio-economic group. %Diet/Tot represents the mean ratio of diet SSBs purchases over total SSBs purchases derived from household level data for each s group.

Estimation

We have estimated the model using a Generalized Method of Moments (GMM) estimator, as described in Berry et al. (1995) and Nevo (2000). To overcome the potential endogeneity issue, we employ an instrumental variables' (IVs) approach using monthly-level observations of cost and supply shifters such as the producer price index (ISTAT), the average price of white sugar within the Community (EC), the average price of plastics used in food packaging (Chambers of Commerce of Milano-Monza-Brianza-Lodi) and fuel price indices (Ministry of Environment and Energy Security), as well as the average package size as IVs.

We have included the following variables to account for the observable product characteristics (X_j): vendor dummy variables (i.e., NB1 to NB10 and PLs); segment dummy variables (i.e., 4 segments, iced tea, cola, other carbonated soft-drinks, and fruits drinks); a dummy variable taking the value of 1 for diet products and 0 for regular SSBs. In addition to the model estimated in Tiboldo et al. (2024), to account for consumers' preferences towards sugar flavour, an explanatory variable Sugar has been included measuring the sugar content of each product. Seasonal and regional fixed effects are also added to control potential systematic differences in SSBs purchases across time periods and geographic areas. Finally, we account for the potential effect of the COVID-19 pandemic and the consequent lockdown in Italy by creating a specific dummy variable taking the value of 1 for the Italian lockdown period (March-May 2020). The demand model is estimated using 11256 market level observations; main results are presented in Table 3.

Table 3. Random coefficient demand model estimation results.

Variable	Parameter estimates	Standard errors
Price	-2.911***	0.358
Price standard deviation (σ)[1]	0.784***	0.165
Price#Middle income	1.097***	0.313
Price#High income	1.657***	0.414
Price#Children	1.022***	0.411
Iced tea	0.143***	0.037
Cola	1.240***	0.037
Fruit drink	2.487***	0.093
Sugar	0.114***	0.003
NB 1	1.985***	0.086
NB 2	3.002***	0.110
NB 3	0.451**	0.067
NB 4	1.433***	0.062
NB 5	0.884***	0.087
NB 6	-1.058***	0.070
NB 7	-0.332	0.076
NB 8	-1.326***	0.066
NB 9	-0.515***	0.065
NB 10	-0.047	0.070
Lockdown	-0.131***	0.033
Constant	-4.776***	0.358
Observations	11256	

Source: Authors' calculation using Nielsen Household Panel data (2019-2020).
[1]The price standard deviation corresponds to the parameter σ and shows how the parameter for price varies with the unobserved household's heterogeneity.

Estimation results show that sugar content is affecting positively consumers' utility, implying that reformulating the product requires to balance a trade-off between the advantage of reducing costs by managing taxation, and the disadvantage of having a product with a lower appreciation.

In Table 4 the average, minimum and maximum value of estimated own-price elasticities, price, price-cost margin, and marginal cost for the whole market, by sugar content and by vendors are presented (more detailed results are reported in Table A.1 and Table A.2 in the Appendix).

Table 4. Statistics (mean, min and max) of the own-price elasticity, market prices, absolute and percentage price-cost margin (PCM and %PCM) and marginal cost (MC) per litre. For all market, by sugar content and by vendors.

Vendor/Type	Elasticity	Price (€/L)	PCM (€/L)	%PCM	MC (€/L)
All	-1.81	1.12	0.64	60.6%	0.48
Minimum	-1.12	0.50	0.47	46.6%	0.03
Maximum	-2.17	1.86	0.97	94.5%	0.88
NBs	-1.89	1.19	0.66	57.5%	0.53
PLs	-1.42	0.72	0.51	76.9%	0.20
Regular	-1.79	1.08	0.62	61.4%	0.45
Diet	-1.91	1.28	0.71	57.4%	0.62

Source: Authors' calculation using Nielsen Household Panel data (2019-2020)

All products are elastic: the average (own-price) elasticity is -1.81. NBs are more sensitive to price changes, and so are diet products. The average PCM is 0.64 €/l, representing 60.6% of the product's price: PLs show a higher profitability compared to NBs, and so are Diet products compared to Regular beverages.

Estimation and simulation results can be differentiated across six different cohorts, obtained by combining households by different socio-economic status (low-income, middle income, high-income) and the presence of children, as in Table 5.

Table 5 – Definition of cohorts in the sample

cohort	inc_lev	child
1	low	0
2	low	1
3	middle	0
4	middle	1
5	high	0
6	high	1

Source: Authors' calculation using Nielsen Household Panel data (2019-2020)

Simulation of SSBs and reformulation

Tax and reformulation scenarios: strategy for simulation

As discussed in the introduction, there are many different SSBs taxation schemes (see also a recent paper by Leibinger et al. 2025). We have excise taxes or sales taxes, flat tax rates or tiered taxes, where the tax rates depend on the sugar content.

In our simulation we have considered three possible taxation schemes and reformulation assumptions. First, we have considered the proposed Italian tax (to be introduced on January 1st, 2027): it is a volumetric excise duty, with a flat rate of €0.10 per Liter on finished products containing added caloric sweeteners, provided their sugar content exceeds 25 grams per Liter (case 1). Second, we have considered an excise tax of 0.103 euro per 100 gr of sugar (0.001 euro per gram of sugar) applied to all SSBs with a sugar content above 50 gr per Liter (case 2). Finally, a two-tier taxation scheme, where the highest tax rate (0.106 euro per Liter) is levied on SSBs with more than 80 g of sugar per litre, while a lower tax rate (0.057 euro per Liter) is levied on SSBs with a sugar content between 50 and 80 g per litre (Case 3). To make policy scenarios comparable, the tax rates are designed in such a way that in the absence of consumers' and firms' reactions, the tax revenues would be the same in all the three cases (Bonnet and Requillart, 2013b).

Regarding reformulation, our simulation strategy is the following: given the tax scheme, we consider that products will be reformulated if a *reasonable* reformulation allows the firm to reduce the burden of taxation (detailed description in Appendix). Following discussion in Leibinger et al. (2025) and empirical evidence, a reduction around 15-25% seems to be a viable choice. Also, considering that taking, for example, 600 €/*t* as an average price for sugar, we have that reducing the sugar content by 1 g would imply a cost reduction of 0.0006 €. On the other hand, taking Stevia as an alternative to sugar, and a (indicative) price of 4 €/kg, and considering that we need about 0.30 g of Stevia to substitute 1 g of sugar, the increase in cost would be 0.00064. Therefore, we have considered that reformulation does not induce a significant change in marginal cost.

We start by comparing the baseline scenario (estimated model) with the two scenarios, under taxation (*tax scenario*) and under taxation+reformulation (*tax+ref scenario*). Then, the key comparison will be between the last two, so to understand the potential incentive for reformulation and to understand how allowing for reformulation and therefore assuming firms strategically behave to cope with the taxation scheme may impact on the consumption of beverages and sugar.

Results from simulation

Case 1

In case 1 we have a volumetric excise duty, with a flat rate of €0.10 per Liter on finished products, provided their sugar content exceeds 25 grams per Liter (the Italian sugar tax). First, we have simulated the impact of the Italian sugar tax on sugar consumption and market equilibrium. Detailed results are included in Table A.3. From the table we have an indication of the taxed products, of the new equilibrium prices, marginal costs and price-cost margins, and of the change in market shares. In Table A.4 we report the effects of the simulation of the excise tax (tax scenario), compared to the baseline scenario. Results do not exactly duplicate those in Tiboldo et al. (2024), since we have used a different empirical specification, introducing the sugar content in the estimated model. Here, in Table 6 we just report some summary results for the taxation scenario (tax scenario), compared to the baseline. The largest effects in percentage terms are for the low-income group, and the presence of a child reduces the impact of taxation; effects are reduced as income increases.

Table 6 – The taxation scenario *vs* the baseline (case 1)

taxation	LOW INCOME		MIDDLE INCOME		HIGH INCOME	
	NO CHILD	CHILD	NO CHILD	CHILD	NO CHILD	CHILD
			SSBs (L)			
% change wrt baseline	-21.0%	-17.7%	-15.6%	-12.4%	-12.7%	-10.9%
			tot sugar (gr)			
% change wrt baseline	-27.59%	-21.97%	-21.38%	-15.20%	-18.39%	-13.10%
			added sugar (gr)			
% change wrt baseline	-27.91%	-22.28%	-21.66%	-15.43%	-18.68%	-13.10%

Source: Authors' calculation using Nielsen Household Panel data (2019-2020)

The important result given our simulation strategy for reformulation is that the Italian sugar tax with a threshold of 25 g/Liter triggering the application of a flat rate of €0.10 per Liter does not provide any (reasonable) incentive for reformulation. Under a flat tax scheme, the marginal incentive to reduce sugar content is effectively zero once the threshold is exceeded. As a result, firms have no economic incentive to undertake reductions in sugar content, since such changes do not reduce the tax burden.

Case 2

In case 2 we have an excise tax of 0.103 euro per 100 gr of sugar (0.001 euro per gram of sugar) applied to all SSBs with a sugar content above 50 gr per Liter. Results from the simulation of the excise tax are reported in Table A.5. In Table A.6 we report the effects of the simulation of the excise tax (tax scenario), compared to the baseline scenario. Again, the largest effects are for the low-income group, while the presence of a child reduces the impact of taxation. In Table A.7 we report the strategy of the simulation of the tax + 20% reformulation. In Table A.8 we report the effects of the simulation of the excise tax + 20%

reformulation (tax+ref scenario) compared to the baseline scenario. For each cohort we observe a pattern like the taxation scenario. In Table 7 we compare the two scenarios (tax *vs* tax+ref).

Table 7 – Comparison of the taxation scenario vs the taxation + reformulation scenario (case 2)

taxation	LOW INCOME		MIDDLE INCOME		HIGH INCOME	
	NO CHILD	CHILD	NO CHILD	CHILD	NO CHILD	CHILD
			SSBs (L)			
% change wrt baseline	-19.36%	-16.72%	-14.59%	-11.90%	-11.95%	-10.60%
baseline cons/year						
			tot sugar (gr)			
% change wrt baseline	-26.99%	-21.75%	-21.14%	-15.13%	-18.24%	-12.97%
baseline cons/year						
			added sugar (gr)			
% change wrt baseline	-27.13%	-21.87%	-21.38%	-15.26%	-18.52%	-12.97%
taxation+reformulation	LOW INCOME		MIDDLE INCOME		HIGH INCOME	
	NO CHILD	CHILD	NO CHILD	CHILD	NO CHILD	CHILD
			SSBs (L)			
% change wrt baseline	-14.53%	-13.15%	-11.37%	-9.79%	-9.55%	-8.69%
baseline cons/year						
			tot sugar (gr)			
% change wrt baseline	-35.94%	-33.32%	-32.70%	-29.59%	-31.02%	-28.15%
baseline cons/year						
			added sugar (gr)			
% change wrt baseline	-35.95%	-33.37%	-32.74%	-29.59%	-31.05%	-28.15%
tax/ref vs tax	LOW INCOME		MIDDLE INCOME		HIGH INCOME	
	NO CHILD	CHILD	NO CHILD	CHILD	NO CHILD	CHILD
			SSBs (L)			
% change wrt baseline	-4.82%	-3.58%	-3.21%	-2.11%	-2.41%	-1.91%
baseline cons/year						
			tot sugar (gr)			
% change wrt baseline	8.96%	11.57%	11.56%	14.46%	12.79%	15.18%
baseline cons/year						
			added sugar (gr)			
% change wrt baseline	8.82%	11.50%	11.36%	14.33%	12.53%	15.18%

Source: Authors' calculation using Nielsen Household Panel data (2019-2020)

In comparing the two scenarios, we concentrate on the effect on the three main variables (consumption of SSBs, Liters per year, total sugar intake, grams per year, and added sugar intake, grams per year), compared to baseline (more details in the Tables in the Appendix). First, we observe that the tax-ref scenario produces a lower reduction in SSBs' consumption, compared to the tax scenario; using reformulation to reduce the tax burden will contain the price increases, thus consumption of beverages will reduce less. However, the tax-ref scenario shows further positive effects in terms of sugar intake, inducing a further reduction between 9% and 15% (in the tax *vs* tax+ref section we compute the difference between the change in the tax scenario and the change in the tax+ref scenario; a positive value indicate that the tax+ref scenario reduces more consumption or intake). It is also worth noting that this additional effect of reformulation follows a different pattern, since it is less intensive for the low-income cohorts, and more for the high-income cohorts.

Table 8 – Firms' profits: tax scenario *vs* tax+ref scenario (case 2)

PROFITS: TAXATION			**PROFITS: TAX + REF**		
product	**diet**	**% change**	**product**	**diet**	**% change**
1	0	-10.49%	1	0	-8.27%
2	0	-15.46%	2	0	-12.07%
3	0	-14.32%	3	0	-13.53%
4	0	-9.58%	4	0	-7.55%
5	0	-17.51%	5	0	-13.13%
6	1	15.38%	6	1	9.66%
7	0	-18.42%	7	0	-14.09%
8	0	-17.20%	8	0	-13.21%
9	0	-29.92%	9	0	-22.34%
10	1	13.57%	10	1	9.05%
11	1	12.36%	11	1	8.59%
12	0	-23.12%	12	0	-17.21%
13	0	13.92%	13	0	9.48%
14	0	-10.45%	14	0	8.02%
15	0	-15.52%	15	0	-12.20%
16	0	-16.72%	16	0	-12.91%
17	0	-19.32%	17	0	-14.82%
18	0	-27.14%	18	0	-20.55%
19	1	12.19%	19	1	8.49%
20	0	-18.91%	20	0	-15.19%
21	0	-16.38%	21	0	-12.93%
22	0	-16.08%	22	0	-12.40%
23	0	-18.41%	23	0	-13.87%
24	0	-17.79%	24	0	-13.19%
25	1	-0.31%	25	1	3.41%
	average	**-12.23%**		**average**	**-9.23%**

Source: Authors' calculation using Nielsen Household Panel data (2019-2020)

Although our reformulation strategy implies an *ad-hoc* choice for the level of reformulation, therefore does not properly derive from firms' profit maximization, some insights about the reliability of reformulation can be obtained by comparing the change in firms' profits across the two scenarios, compared to the baseline, as in Table 8. Both scenarios produce a reduction in firms' profits for regular products (only profits for diet products increase), but the tax-ref scenario is to be preferred for the firms,since it is relatively profit-improving compared with taxation alone. On average the tax scenario reduces profits by 12.23%, while the tax+ref scenario contains such reduction to 9.23%, giving some economic support to the idea that taxation may incentivise products' reformulation.

Case 3

In case 3 we have a two-tier taxation scheme, where the highest tax rate (0.106 euro per Liter) is levied on SSBs with more than 80 g of sugar per Liter, while a lower tax rate (0.057 euro per Liter) is levied on SSBs with a sugar content between 50 and 80 g per Liter. Here we have applied the same simulation strategy as before but given the structure of the tax when the 20% exogenous sugar reduction takes below any of the two thresholds, we have limited reformulation only to the reduction allowing to meet the threshold for the lower flat rate (see the Appendix).

Results from the simulation of the excise tax are reported in Table A.9. In Table A.10 we report the effects of the simulation of the excise tax (tax scenario), compared to the baseline scenario. As for case 1 and case 2, the largest effects are for the low-income group, while the presence of a child reduces the impact of taxation. In Table A.11 we report the strategy of the simulation of the tax + 20% reformulation, as detailed above. In Table A.12 we report the effects of the simulation of the excise tax + 20% reformulation (tax+ref scenario) compared to the baseline scenario. For each cohort we observe a pattern similar to the taxation scenario, with the largest effects for the low-income group, while the presence of a child reduces the impact. In table 7 we compare the two scenarios (tax *vs* tax+ref).

In Table 9 we compare the two scenarios (tax *vs* tax+ref), concentrating on consumption of SSBs, total sugar intake, and added sugar intake. We confirm results from case 2, with the tax-ref scenario inducing a lower reduction in SSBs' consumption, compared to the tax scenario. Similarly, under the tax+ref scenario we have additional effects in terms of sugar intake, although reformulation will imply that we consume more SSBs, the tax-ref scenario shows further positive effects in terms of sugar intake, inducing a further reduction between 6% and 13%, less intensive for the low-income cohorts, and more for the high-income cohorts.

Table 9 – Comparison of the taxation scenario vs the taxation + reformulation scenario (case 3)

taxation	LOW INCOME		MIDDLE INCOME		HIGH INCOME	
	NO CHILD	CHILD	NO CHILD	CHILD	NO CHILD	CHILD
			SSBs (L)			
% change wrt baseline	-20.4%	-17.4%	-15.1%	-12.1%	-12.3%	-10.8%
			tot sugar (gr)			
% change wrt baseline	-27.9%	-22.4%	-21.6%	-15.3%	-18.5%	-13.3%
			added sugar (gr)			
% change wrt baseline	-28.3%	-22.7%	-22.0%	-15.6%	-18.9%	-13.3%
taxation + reformulation	LOW INCOME		MIDDLE INCOME		HIGH INCOME	
	NO CHILD	CHILD	NO CHILD	CHILD	NO CHILD	CHILD
			SSBs (L)			
% change wrt baseline	-13.5%	-12.1%	-10.5%	-9.1%	-9.0%	-8.2%
			tot sugar (gr)			
% change wrt baseline	-32.5%	-29.7%	-29.5%	-25.7%	-27.5%	-26.3%
			added sugar (gr)			
% change wrt baseline	-33.5%	-30.8%	-31.4%	-27.7%	-29.8%	-26.3%
tax/ref vs tax	LOW INCOME		MIDDLE INCOME		HIGH INCOME	
	NO CHILD	CHILD	NO CHILD	CHILD	NO CHILD	CHILD
			SSBs (L)			
% change wrt baseline	-6.9%	-5.3%	-4.6%	-3.1%	-3.3%	-2.7%
			tot sugar (gr)			
% change wrt baseline	4.6%	7.4%	7.8%	10.3%	9.0%	13.0%
			added sugar (gr)			
% change wrt baseline	5.2%	8.1%	9.4%	12.2%	10.9%	13.0%

Source: Authors' calculation using Nielsen Household Panel data (2019-2020)

In the following Table 10, we compare the two scenarios in terms of firms' profits. As for case 2, we see that allowing for reformulation firms may exploit the possibility to reduce/avoid the tax burden to contain consumption changes, and consequently to contain the losses of taxation. On average the tax scenario reduces profits by 12.64%, while the tax+ref scenario gives a 7.06% reduction.

Table 10 – Firms' profits: tax scenario *vs* tax+ref scenario (case 3)

PROFITS: TAXATION			PROFITS: TAX+REF		
product	**diet**	**% change**	**product**	**diet**	**% change**
1	0	-4.07%	1	0	-9.18%
2	0	-19.28%	2	0	-9.73%
3	0	-15.65%	3	0	-9.40%
4	0	-6.14%	4	0	8.13%
5	0	-23.49%	5	0	-11.82%
6	1	15.62%	6	1	9.43%
7	0	-18.27%	7	0	-8.90%
8	0	-23.50%	8	0	-12.03%
9	0	-30.24%	9	0	-15.97%
10	1	13.56%	10	1	8.79%
11	1	12.54%	11	1	8.17%
12	0	-20.24%	12	0	-25.17%
13	0	13.89%	13	0	9.21%
14	0	-11.46%	14	0	7.60%
15	0	-16.47%	15	0	-8.10%
16	0	-18.32%	16	0	-8.83%
17	0	-17.97%	17	0	-22.56%
18	0	-29.16%	18	0	-15.72%
19	1	12.30%	19	1	8.08%
20	0	-14.00%	20	0	-21.22%
21	0	-15.31%	21	0	-20.97%
22	0	-19.17%	22	0	-9.29%
23	0	-18.44%	23	0	-8.69%
24	0	-15.99%	24	0	-21.93%
25	1	-1.24%	25	1	8.32%
	average	**-12.64%**		**average**	**-7.06%**

Source: Authors' calculation using Nielsen Household Panel data (2019-2020)

Discussion of the results and scenarios' comparison

In the appendix we report some summary tables for comparisons across scenarios.

In Table A.13 we observe percentage changes in prices and shares. Results from the three taxation schemes are overall in line with those in Tiboldo et al. (2024), although under a different model specification. For the Italian sugar tax scenario (case 1), prices of all regular SSBs increase from 9.0% to 33.1% after taxation (except for products 13 which is not subject to taxation given its sugar content), with larger effects on PLs. On the other hand, prices of diet products show small changes in percentage terms, with the only exception being product 25. For the proportional excise tax, we observe an increase from 8.8% to 35.1% of prices for regular SSBs, although the structure of the tax determines a different distribution across products. Similarly, the effects on PLs. Finally, for the two-tier taxation scheme (case 3) prices of regular SSBs are reduced from 6.0% to 34.6%. Comparing the three scenarios, we may say that the larger effects (on both prices and market shares) are given by the Italian sugar tax, while the other two taxation schemes produce slightly lower but similar effects.

In Table A.14 changes at the demand side are presented. Since the primary goal of SSB taxation is to curb the consumption of sugary drinks and overall sugar intake, we assess the effectiveness of the simulated tax schemes in reducing both SSB and sugar consumption across Italian households. Consistent with previous findings (Bonnet and Requillart, 2013a; Tiboldo et al., 2024), our findings indicate that all tax schemes lead to substantial reductions in SSB consumption (Liters/year). Following the discussion on the price changes induced by the taxation schemes, we have a slightly higher reduction in consumption for the Italian sugar tax (-15.1% on average). It is worth noting that, compared to results in Tiboldo et al. (2024), our different specification of the demand model leads to a lower reduction in consumption. The two other taxation schemes lead to a similar reduction in consumption. As previously discussed there a distribution of the effects across cohorts: differences across taxation schemes in terms of SSBs' consumption tend to mitigate as income increases. In terms of sugar intakes (grams/year), the three taxation schemes provide similar results, on average: the reduction in sugar intake is around 20% (the Italian tax shows the smallest reduction) for both total sugar and added sugar, indicating that most of the effect comes from reducing the consumption of taxed products with higher sugar content. We also observe a distribution across cohorts, like that discussed for consumption.

Finally, we can also compare the tax+ref scenarios. The first important conclusion, as expected, is that the way in which taxation schemes are structured may provide different incentives for reformulation. Under our exogenous reformulation strategy, the Italian sugar tax scheme does not give any incentive to reformulate the product to reduce the tax burden. On the other hand, the two other taxation schemes (case 2 and case 3) give incentives to reformulate the product. First, reformulation allows firms to contain the reduction in the consumption of the products, because of the lower impact on prices (i.e., reformulation allows them to reduce the impact on marginal cost, as in equation (19)). However, the impact on sugar intake is amplified by the combination of a taxation scheme and a reformulation strategy. The two-tier tax scheme gives an average reduction in sugar intake (either added or total) around 29-30% (compared to the 19-20% effect of the tax alone); the proportional tax scheme appears to be the most effective in incentivizing reformulation, and the reduction in sugar intake is around 33.5%, on average. In other words, reformulation creates a trade-off between *quantity* and *quality* effects. Under taxation only, the reduction in sugar intake comes only from a quantity effect on beverages' consumption, while under taxation + reformulation, the reduction in sugar intake comes from the combination of a (lower) quantity effect and a quality effect, linked to the change in the product formula (less sugar per Liter).

Overall, the results indicate that the design of the tax structure plays a crucial role once firms are allowed to adjust product characteristics. While different taxation schemes may yield similar outcomes in terms of consumption reduction when reformulation is not considered, their effectiveness diverges substantially when firms respond strategically. In particular, proportional taxes provide continuous incentives to reduce sugar content, leading to larger reductions in total sugar intake, whereas tiered taxes generate threshold-based incentives that may limit the extent of reformulation. The Italian sugar tax has a very low threshold for application (20 g/liter), above which a flat tax rate is applied; as such, it widens the range of products on which the tax is applied, but the flat tax rate prevent reformulation for most products, since it would affect excessively the taste. The other two taxation schemes give incentive to reformulate. The proportional tax (a tax rate per gram of sugar above 50 g/Liter) is the most impacting on sugar intake (the ultimate goal of a sugar tax) is the most effective one, since it does not limit the reformulation strategy. On the other hand, the two-tier tax (two thresholds, at 50 g/Liter and 80 g/Liter with different flat tax rates) translate into a smaller reduction in sugar intake, for one main reason. Firms have an incentive to reformulate the product to the extent that, by implementing an approximate reduction of up to 20–25%, they can reach the nearest threshold. However, under a proportional tax, there may be an incentive to carry out the full reduction in sugar, since every less gram of sugar leads to a corresponding decrease in the tax. In contrast, under a two-tier scheme, the incentive is only to reach the nearest threshold; if this can be achieved with a more limited reformulation, there is no reason to reformulate the product further, as doing so would not change the tax burden.

Table 10 – Welfare comparisons

	Italian sugar tax	proport tax on sugar cont	two-tier tax	REF: proport tax on sugar	REF: Two tier tax
delta CS (€/anno)	-74106305.3	-74382548.1	-73806978.8	-67569190.0	-56111389.4
delta PS (€/anno)	-63463849.6	-61825375.1	-62237597.4	-44726158.5	-34781310.1
delta PS (%)	-12.9%	-12.55%	-12.64%	-9.08%	-7.06%
tax revenue (€/anno)	48829141.4	48834046.1	48441971.3	36970689.7	29505334.0
social welfare loss (€/anno)	-88741013.6	-87373877.1	-87602605.0	-75324658.8	-61387365.5

Source: Authors' calculation using Nielsen Household Panel data (2019-2020)

Additional insights emerge from the analysis of the effects of the different scenarios on firm outcomes. Table 11 compares the various scenarios. As expected, there is a reduction in consumer welfare (measured as the change in consumer surplus), mainly driven by price effects. It should be noted, however, that this negative effect does not account for the positive health impact - unobservable within our model - associated with the reduction in sugar intake.

Some more interesting implications come from the analysis of the average effect on firms (see also Table 8 and Table 10). In this case, the introduction of a taxation scheme leads to a reduction in firms' profits (measured as producer surplus). From this perspective, the three different tax schemes do not generate substantial differences for firms on average, with profits declining by around 12.5–13%. It is also worth noting that tax revenues are similar across all schemes, which is consistent with how the three taxation scenarios were designed, maintaining revenue neutrality.

More relevant implications emerge when considering the tax+ref scenarios. The first observation is that adopting a reformulation strategy appears to create a market incentive for firms, as it mitigates the losses associated with taxation. This is mainly driven by the smaller negative impact on beverage consumption. These incentives are present in both simulated schemes (case 2 and case 3); therefore, given the structure of our model, reformulation is advantageous for firms. Second, Case 3 (two-tier scheme) appears to deliver the best performance for firms, limiting losses. This suggests that a tax scheme of this type, while achieving results similar to the proportional excise tax (case 2) in terms of reducing sugar intake, is preferable for companies.

Policy implications

The results of the simulation provide several relevant policy implications regarding the design of sugar-sweetened beverage (SSB) taxes. First, while all taxation schemes considered are effective in reducing both SSB consumption and sugar intake, their effectiveness differs substantially once firms are allowed to respond through product reformulation. This highlights the importance of accounting for firms' strategic behavior when designing fiscal interventions in this context.

A key implication concerns the role of tax structure. Flat volumetric taxes with low thresholds, such as the Italian sugar tax, tend to generate broad coverage across products but provide limited incentives for reformulation. Once a product exceeds the threshold, marginal reductions in sugar content do not reduce the tax burden, thereby discouraging incremental reformulation efforts. As a result, these schemes primarily operate through price increases and reductions in consumption, rather than through improvements in product composition.

In contrast, taxes that are directly linked to sugar content—such as proportional taxes or tiered systems—create stronger incentives for reformulation. In particular, proportional taxes provide continuous incentives to reduce sugar content, as every additional gram of sugar is taxed. This leads to more substantial reductions in overall sugar intake, even when the reduction in consumption is smaller compared to a tax-only scenario. Tiered taxes also encourage reformulation, although incentives are concentrated around threshold values, which may limit the extent of sugar reduction if firms only target the nearest tax bracket.

Another important implication concerns the interaction between consumption and reformulation effects. While reformulation may attenuate the reduction in SSB consumption by limiting price increases, it significantly enhances the reduction in sugar intake by lowering the sugar content per unit. From a public health perspective, this suggests that policies should prioritize mechanisms that encourage reformulation, as they can achieve larger improvements in dietary outcomes without relying exclusively on behavioral change.

Finally, the results also suggest that reformulation may mitigate some of the regressive effects typically associated with consumption taxes. Since low-income households are more price-sensitive, they experience larger reductions in consumption, while higher-income households benefit relatively more from improvements in product quality. This distributional pattern should be carefully considered in policy design, especially when evaluating the equity implications of SSB taxation.

Overall, the findings indicate that the effectiveness of SSB taxation depends not only on the level of the tax, but crucially on its structure and its ability to induce supply-side adjustments. Policies that align fiscal incentives with product reformulation are likely to be more effective in achieving sustained reductions in sugar intake.

Limitations

To conclude, however, we must stress that our simulation strategy has been built in our model in an *ad-hoc* manner, imposing a 20% reduction in the sugar content, following some empirical evidence across countries. To have more definitive answers we should be able to obtain definitive answers, we would need a model in which decisions regarding product pricing and the optimal level of reformulation are made simultaneously. Some additional insights could be gained by comparing different levels of reformulation.

Further, in the overall evaluation we are not able to quantify the gain from reducing sugar intake (in terms of either internalities or externalities) and the potential benefits of using tax revenues. Finally, nothing can be said in our model about the possible signaling effect of a sugar tax, further influencing consumers' response.

References

Allais, Olivier, Céline Bonnet, Vincent Réquillart, Marine Spiteri & Maxime Tranchard. 2023. "Reformulation and taxes for healthier consumption: Empirical evidence in the French Dessert market." *Working Paper*. https://econphd-paris-saclay.fr/papers23/MaximeTranchard.pdf

Andreyeva, Tatiana, Frank J. Chaloupka & Kelly D. Brownell. 2011. "Estimating the Potential of Taxes on Sugar-Sweetened Beverages to Reduce Consumption and Generate Revenue." *Preventive Medicine* 52 (6): 413–16. https://doi.org/10.1016/j.ypmed.2011.03.013

Andreyeva, Tatiana, Keith Marple, Samantha Marinello, Timothy E. Moore & Lisa M. Powell. 2022. "Outcomes Following Taxation of Sugar-Sweetened Beverages: A Systematic Review and Meta-Analysis." *JAMA Network Open* 5 (6): e2215276. https://doi.org/10.1001/jamanetworkopen.2022.15276

Berry, Steven, James Levinsohn & Ariel Pakes. 1995. "Automobile Prices in Market Equilibrium." *Econometrica* 63 (4): 841–90. https://doi.org/10.2307/2171802

Bonnet, Céline & Vincent Requillart. 2011. "Does the EU Sugar Policy Reform Increase Added Sugar Consumption? An Empirical Evidence on the Soft Drink Market." *Health Economics* 20 (9): 1012–24. https://doi.org/10.1002/hec.1721

Bonnet, Céline & Vincent Réquillart. 2013a. "Impact of Cost Shocks on Consumer Prices in Vertically-Related Markets: The Case of The French Soft Drink Market." *American Journal of Agricultural Economics* 95 (5): 1088–1108. https://doi.org/10.1093/ajae/aat055

———. 2013b. "Tax Incidence with Strategic Firms in the Soft Drink Market." *Journal of Public Economics* 106 (October): 77–88. https://doi.org/10.1016/j.jpubeco.2013.06.010

Capacci, Sara, Olivier Allais, Celine Bonnet & Mario Mazzocchi. 2019. "The Impact of the French Soda Tax on Prices and Purchases. An Ex Post Evaluation." Edited by Bhavani Shankar. *PLOS ONE* 14 (10): e0223196. https://doi.org/10.1371/journal.pone.0223196

Cawley, John & David E. Frisvold. 2017. "The Pass-Through of Taxes on Sugar-Sweetened Beverages to Retail Prices: The Case of Berkeley, California." *Journal of Policy Analysis and Management* 36 (2): 303–26. https://doi.org/10.1002/pam.21960

Chidmi, Benaissa. 2012. "'Vertical Relationships in the Ready-to-Eat Breakfast Cereal Industry in Boston.'" *Agribusiness* 28 (3): 241–59. https://doi.org/10.1002/agr.21294

Cornelsen, Laura & Richard D. Smith. 2018. "Viewpoint: Soda Taxes – Four Questions Economists Need to Address." *Food Policy* 74 (January): 138–42. https://doi.org/10.1016/j.foodpol.2017.12.003

Forde, Hannah, Tarra L. Penney, Martin White & Jean Adams. 2023. "Is Reformulation Still a Suitable Goal for Sugary Beverage Taxes? A Response to Recent Commentaries." *International Journal of Health Policy and Management*, 12:8366. https://www.ijhpm.com/article_4544_82da807af08e3161bcc1cbad9ab8343e.pdf

Hausman, Jerry A. & Gregory K. Leonard. 2002. "The Competitive Effects of a New Product Introduction: A Case Study." *The Journal of Industrial Economics* 50 (3): 237–63. https://doi.org/10.1111/1467-6451.00176.

Hirsch, Stefan, Giulia Tiboldo & Rigoberto A. Lopez. 2018. "A Tale of Two Italian Cities: Brand-Level Milk Demand and Price Competition." *Applied Economics* 50 (49): 5239–52. https://doi.org/10.1080/00036846.2018.1486016

Jones-Smith, Jessica C., Melissa A. Knox, Norma B. Coe, Lina P. Walkinshaw, John Schoof, Deven Hamilton, Philip M. Hurvitz & James Krieger. 2022. "Sweetened Beverage Taxes: Economic Benefits and Costs According to Household Income." *Food Policy* 110 (July): 102277. https://doi.org/10.1016/j.foodpol.2022.102277

Kim, Donghun. 2004. "Estimation of the Effects of New Brands on Incumbents' Profits and Consumer Welfare: The U.S. Processed Cheese Market Case." *Review of Industrial Organization* 25 (3): 275–93. https://doi.org/10.1007/s11151-004-3172-6

Kim, Donghun & Ronald W. Cotterill. 2008. "Cost Pass-Through in Differentiated Product Markets: The Case of U.S. Processed Cheese*." *The Journal of Industrial Economics* 56 (1): 32–48. https://doi.org/10.1111/j.1467-6451.2008.00331.x

Le Bodo, Yann, Fabrice Etilé, Chantal Julia, Marine Friant-Perrot, Eric Breton, Sébastien Lecocq, Christine Boizot-Szantai, Céline Bergeran & Françoise Jabot. 2022. "Public Health Lessons from the French 2012 Soda Tax and Insights on the Modifications Enacted in 2018." *Health Policy* 126 (7): 585–91. https://doi.org/10.1016/j.healthpol.2022.04.012

Leibinger, Anna, Oliver Huizinga, Karl Emmert-Fees, Sara Pedron, Michael Laxy, Eva Rehfuess, Jacob Burns & Peter von Philipsborn. 2025. "The Impact of Tiered Soft Drink Taxes in Europe on Mean Sales-Weighted Sugar Content of Soft Drinks: A Quasi-Experimental Study." BMC Public health 25:2106. https://doi.org/10.1186/s12889-025-23331-w

Lopez, Elena & Rigoberto A. Lopez. 2009. "Demand for Differentiated Milk Products: Implications for Price Competition." *Agribusiness* 25 (4): 453–65. https://doi.org/10.1002/agr.20219

Nevo, Aviv. 2000. "A Practitioner's Guide to Estimation of Random-Coefficients Logit Models of Demand." *Journal of Economics & Management Strategy* 9 (4): 513–48. https://doi.org/10.1111/j.1430-9134.2000.00513.x

———. 2001. "Measuring Market Power in the Ready-to-Eat Cereal Industry." *Econometrica* 69 (2): 307–42. https://doi.org/10.1111/1468-0262.00194

Rogers, Nina, Steven Cummins, Catrin P Jones, Oliver Mytton, Mike Rayner, Harry Rutter, Martin White & Jean Adams. 2024. "Estimated changes in free sugar consumption one year after the UK soft drinks industry levy came into force: controlled interrupted time series analysis of the National Diet and Nutrition Survey (2011-2019)." *Journal of Epidemiology and Community Health* 78(9): 578-84. https://jech.bmj.com/content/jech/78/9/578

Rojas, Christian & Emily Wang. 2021. "Do Taxes on Soda and Sugary Drinks Work? Scanner Data Evidence from Berkeley and Washington State." *Economic Inquiry* 59 (1): 95–118. https://doi.org/10.1111/ecin.12957

Scarborough, Peter, Vyas Adhikari, Richard A. Harrington, Ahmed Elhussein, Adam Briggs, Mike Rayner, Jean Adams, Steven Cummins, Tarra Penney & Martin White.2020. "Impact of the announcement and implementation of the UK Soft Drinks Industry Levy on sugar content, price, product size and number of available soft drinks in the UK, 2015-19: A controlled interrupted time series analysis." *PLOSMedicine* 17(2): 1-19. https://doi.org/10.1371/journal.pmed.1003025

Thow, Anne Marie, Holly L. Rippin, Georgina Mulcahy, Keeva Duffey & Kremlin Wickramasinghe. 2022. "Sugar-Sweetened Beverage Taxes in Europe: Learning for the Future." *European Journal of Public Health* 32 (2): 273–80. https://doi.org/10.1093/eurpub/ckab211

Tiboldo, Giulia, Elena Castellari & Daniele Moro. 2024. "The distributional implications of health taxes: A case study on the Italian sugar tax." *Food Policy*, 126, 102671. https://doi.org/10.1016/j.foodpol.2024.102671

UK Government. 2025. "Strengthening the Soft Drinks Industry Levy — Summary of responses". https://www.gov.uk/government/consultations/strengthening-the-soft-drinks-industry-levy/outcome/strengthening-the-soft-drinks-industry-levy-summary-of-responses?utm_source=chatgpt.com

Villas-Boas, Sofia Berto. 2007. "Vertical Relationships between Manufacturers and Retailers: Inference with Limited Data." *The Review of Economic Studies* 74 (2): 625–52. https://doi.org/10.1111/j.1467-937X.2007.00433.x

Zhang, Yunjunjie & Marco Palma. 2021. "Revisiting Sugar Taxes and Sugary Drink Consumption: Evidence from the Random-Coefficient Demand Model." *Journal of Agricultural and Resource Economics* 46 (1). https://econpapers.repec.org/article/agsjlaare/303601.htm

World Health Organization (WHO). 2015. Fiscal policies for diet and prevention of non-communicable diseases. Technical meeting report, 5-6 May 2015. Geneva, Switzerland. Available at: https://www.who.int/docs/default-source/obesity/fiscal-policies-for-diet-and-the-prevention-of-noncommunicable-diseases-0.pdf?sfvrsn=84ee20c_2 (accessed: 21/03/2025).

World Health Organization (WHO). 2017. Taxes on sugary drinks: Why do it?. http://apps.who.int/iris/bitstream/handle/10665/260253/WHO-NMH-PND-16.5Rev.1-eng.pdf (accessed: 21/03/2025).

World Health Organization (WHO). 2022. "Reformulation of food and beverage products for healthier diets: policy brief". Available at: https://iris.who.int/bitstream/handle/10665/355755/9789240039919-eng.pdf?sequence=1 (accessed: 21/03/2025).

Appendix to Deliverable 4.1

Reformulation strategy

Given the low sugar threshold that guarantees exemption from taxation, the Italian sugar tax does not create incentives for reformulation (i.e., even assuming a 20% reduction in sugar, no product would fall below a sugar content of 25 grams per liter, except for those already exempt from taxation).

Therefore, for this scenario we did not simulate reformulation. Instead, for the other two scenarios we assumed an "exogenous reformulation" leading to a 20% reduction in sugar. Precisely:

1. **Propotional excise tax_REF**: the incentive to reformulate applies to all products with sugar content above 50 grams per liter, because this leads to a "saving" in terms of the tax rate (which is proportional to sugar content), up to the threshold value of 50 grams per liter, beyond which further reformulation is no longer meaningful as the product becomes exempt from the excise tax.
   Note: for products "close" to the exemption threshold, we assume that reformulation goes slightly further to reach 50 grams per liter (e.g., for product 4, which with a 20% sugar reduction would reach 54.5 grams per liter, we assume reformulation continues until reaching 50 grams per liter). This applies only to products where the additional reformulation requires a further sugar reduction of no more than 5 grams per liter.
2. **Two-tier excise tax_REF**: the incentive to reformulate applies to all products with sugar content above 50 grams per liter or 80 grams per liter, because this leads to a "saving" in terms of the tax rate until reaching the threshold of 50 or 80 grams per liter, beyond which further reformulation is no longer meaningful as the product becomes exempt from the excise tax or moves down to the tier 1 tax rate.
   Note: also in this case, for products "close" to exemption or to the transition from tax rate 2 (0.106) to tax rate 1 (0.057), we assume that reformulation goes slightly further to reach 50 or 80 grams per liter. This applies only to products where the additional reformulation requires a further sugar reduction of no more than 5 grams per liter.

Table A.1

Summary results from estimation

product	brand	segment	segm_label	type	sugar (gr/100ml)	% fruit	fruit sugar	add. sugar (gr/100ml)	**share**	**price**	**own price elasticity**	**PCM**	**PCM%**	**MC**
1	NB1	1	The	R	7.82	0.00	0.00	7.82	0.0061	1.18	-2.01	0.63	63.20	0.44
2	NB10	1	The	R	9.13	0.00	0.00	9.13	0.0029	0.94	-1.78	0.56	56.28	0.41
3	NB2	1	The	R	10.09	0.00	0.00	10.09	0.1104	1.86	-1.94	0.52	52.39	0.88
4	NB4	1	The	R	6.81	0.00	0.00	6.81	0.0092	0.93	-1.75	0.59	58.92	0.38
5	PLs	1	The	R	8.59	0.00	0.00	8.59	0.0078	0.75	-1.51	0.69	69.25	0.23
6	NB2	1	The	D	0.34	0.00	0.00	0.00	0.0144	1.85	-2.17	0.52	52.36	0.88
7	NB1	2	Cola	R	10.65	0.00	0.00	10.65	0.1306	1.26	-1.80	0.61	61.31	0.49
8	NB3	2	Cola	R	8.58	0.00	0.00	8.58	0.0183	0.81	-1.59	0.63	63.18	0.30
9	PLs	2	Cola	R	10.46	0.00	0.00	10.46	0.0025	0.45	-1.12	0.95	94.51	0.03
10	NB1	2	Cola	D	0.00	0.00	0.00	0.00	0.0518	1.26	-1.96	0.61	61.28	0.49
11	NB3	2	Cola	D	0.00	0.00	0.00	0.00	0.0036	0.81	-1.61	0.63	63.12	0.30
12	NB1	3	Other soft-drinks	R	11.57	12.00	1.39	10.18	0.0158	1.05	-1.87	0.68	67.51	0.34
13	NB1	3	Other soft-drinks	R	1.93	0.00	0.00	1.93	0.0047	1.10	-1.93	0.66	65.82	0.37
14	NB4	3	Other soft-drinks	R	5.41	0.00	0.00	5.41	0.0053	0.57	-1.24	0.84	83.51	0.09
15	NB4	3	Other soft-drinks	R	10.22	0.00	0.00	10.22	0.0177	1.28	-2.04	0.50	49.73	0.64
16	NB5	3	Other soft-drinks	R	10.00	0.00	0.00	10.00	0.0043	1.11	-1.94	0.52	51.96	0.53
17	NB5	3	Other soft-drinks	R	11.07	0.00	0.00	11.07	0.0098	1.12	-1.95	0.52	51.63	0.54
18	PLs	3	Other soft-drinks	R	9.96	0.00	0.00	9.96	0.0081	0.53	-1.17	0.90	89.54	0.06
19	NB4	3	Other soft-drinks	D	0.42	0.00	0.00	0.00	0.0041	0.83	-1.63	0.63	63.37	0.30
20	NB9	4	Fruit drink	R	12.39	50.55	6.41	5.98	0.0303	1.64	-2.15	0.47	46.60	0.88
21	NB8	4	Fruit drink	R	10.98	28.13	3.08	7.90	0.0113	1.41	-2.13	0.47	46.97	0.75
22	NB7	4	Fruit drink	R	9.47	29.89	2.82	6.66	0.0077	1.03	-1.87	0.54	53.58	0.48
23	PLs	4	Fruit drink	R	10.54	35.01	3.78	6.76	0.0323	1.09	-1.87	0.54	54.27	0.50
24	NB6	4	Fruit drink	R	11.22	30.39	3.39	7.82	0.0119	1.37	-2.11	0.48	48.36	0.71
25	NB6	4	Fruit drink	D	5.31	50.13	5.11	0.20	0.0186	1.62	-2.17	0.47	46.60	0.87

Table A.2

Matrix of price-elasticities for all products (own-price elasticities in boxes)

	prod1	prod2	prod3	prod4	prod5	prod6	prod7	prod8	prod9	prod10	prod11	prod12	prod13	prod14	prod15	prod16	prod17	prod18	prod19	prod20	prod21	prod22	prod23	prod24	prod25
prod1	-2.005	0.005	0.287	0.015	0.011	0.037	0.282	0.027	0.002	0.112	0.005	0.029	0.009	0.006	0.038	0.008	0.019	0.008	0.006	0.076	0.026	0.014	0.062	0.027	0.046
prod2	0.013	-1.777	0.279	0.016	0.012	0.036	0.291	0.029	0.003	0.115	0.006	0.031	0.010	0.006	0.040	0.009	0.020	0.009	0.007	0.076	0.027	0.015	0.066	0.028	0.046
prod3	0.010	0.004	-1.942	0.012	0.008	0.033	0.231	0.020	0.002	0.092	0.004	0.023	0.007	0.004	0.032	0.007	0.015	0.005	0.005	0.067	0.022	0.011	0.049	0.023	0.041
prod4	0.013	0.005	0.279	-1.747	0.012	0.036	0.291	0.030	0.003	0.115	0.006	0.031	0.010	0.006	0.040	0.009	0.020	0.009	0.007	0.075	0.027	0.015	0.066	0.028	0.046
prod5	0.013	0.005	0.268	0.017	-1.513	0.035	0.294	0.031	0.003	0.116	0.006	0.032	0.010	0.007	0.040	0.009	0.021	0.010	0.007	0.074	0.026	0.015	0.067	0.028	0.045
prod6	0.010	0.004	0.258	0.012	0.008	-2.167	0.232	0.020	0.002	0.092	0.004	0.023	0.007	0.004	0.032	0.007	0.015	0.005	0.005	0.067	0.022	0.011	0.049	0.023	0.041
prod7	0.012	0.005	0.288	0.015	0.010	0.037	-1.796	0.026	0.002	0.110	0.005	0.029	0.009	0.005	0.038	0.008	0.019	0.008	0.006	0.076	0.026	0.014	0.061	0.027	0.046
prod8	0.013	0.005	0.273	0.017	0.012	0.035	0.293	-1.589	0.003	0.116	0.006	0.032	0.010	0.007	0.040	0.009	0.021	0.009	0.007	0.075	0.027	0.015	0.067	0.028	0.046
prod9	0.013	0.006	0.250	0.018	0.013	0.033	0.292	0.033	-1.117	0.116	0.006	0.033	0.010	0.007	0.040	0.009	0.021	0.011	0.007	0.070	0.026	0.016	0.068	0.027	0.043
prod10	0.012	0.005	0.288	0.015	0.010	0.037	0.278	0.026	0.002	-1.964	0.005	0.029	0.009	0.005	0.038	0.008	0.019	0.008	0.006	0.076	0.026	0.014	0.061	0.027	0.046
prod11	0.013	0.005	0.273	0.017	0.012	0.035	0.293	0.031	0.003	0.116	-1.615	0.032	0.010	0.007	0.040	0.009	0.021	0.009	0.007	0.075	0.027	0.015	0.067	0.028	0.046
prod12	0.013	0.005	0.284	0.016	0.011	0.037	0.288	0.028	0.002	0.114	0.006	-1.867	0.009	0.006	0.039	0.009	0.020	0.009	0.007	0.076	0.026	0.015	0.064	0.028	0.046
prod13	0.013	0.005	0.285	0.016	0.011	0.037	0.286	0.028	0.002	0.113	0.005	0.030	-1.934	0.006	0.039	0.009	0.020	0.008	0.006	0.076	0.026	0.015	0.064	0.028	0.047
prod14	0.013	0.006	0.256	0.018	0.013	0.033	0.293	0.032	0.003	0.116	0.006	0.033	0.010	-1.239	0.040	0.009	0.021	0.010	0.007	0.071	0.026	0.016	0.068	0.027	0.044
prod15	0.012	0.005	0.288	0.015	0.010	0.037	0.278	0.026	0.002	0.110	0.005	0.029	0.009	0.005	-2.045	0.008	0.019	0.008	0.006	0.076	0.026	0.014	0.061	0.027	0.046
prod16	0.013	0.005	0.285	0.016	0.011	0.037	0.285	0.028	0.002	0.113	0.005	0.030	0.009	0.006	0.039	-1.944	0.020	0.008	0.006	0.076	0.026	0.014	0.064	0.027	0.047
prod17	0.013	0.005	0.286	0.016	0.011	0.037	0.285	0.028	0.002	0.113	0.005	0.030	0.009	0.006	0.039	0.009	-1.945	0.008	0.006	0.076	0.026	0.014	0.063	0.027	0.047
prod18	0.013	0.006	0.253	0.018	0.013	0.033	0.293	0.033	0.003	0.116	0.006	0.033	0.010	0.007	0.040	0.009	0.021	-1.172	0.007	0.071	0.026	0.016	0.068	0.027	0.043
prod19	0.013	0.005	0.274	0.017	0.012	0.036	0.293	0.030	0.003	0.116	0.006	0.032	0.010	0.006	0.040	0.009	0.021	0.009	-1.634	0.075	0.027	0.015	0.067	0.028	0.046
prod20	0.011	0.004	0.276	0.013	0.009	0.036	0.252	0.022	0.002	0.100	0.004	0.025	0.008	0.004	0.034	0.007	0.017	0.006	0.005	-2.146	0.024	0.012	0.054	0.025	0.044
prod21	0.012	0.005	0.286	0.014	0.010	0.037	0.270	0.025	0.002	0.107	0.005	0.028	0.009	0.005	0.037	0.008	0.018	0.007	0.006	0.075	-2.129	0.013	0.059	0.026	0.046
prod22	0.013	0.005	0.283	0.016	0.011	0.037	0.288	0.029	0.002	0.114	0.006	0.031	0.009	0.006	0.039	0.009	0.020	0.009	0.007	0.076	0.026	-1.866	0.065	0.028	0.046
prod23	0.013	0.005	0.285	0.016	0.011	0.037	0.286	0.028	0.002	0.113	0.005	0.030	0.009	0.006	0.039	0.009	0.020	0.008	0.006	0.076	0.026	0.015	-1.875	0.028	0.047
prod24	0.012	0.005	0.287	0.014	0.010	0.037	0.272	0.025	0.002	0.108	0.005	0.028	0.009	0.005	0.037	0.008	0.019	0.007	0.006	0.075	0.025	0.013	0.059	-2.112	0.046
prod25	0.011	0.004	0.277	0.013	0.009	0.036	0.253	0.022	0.002	0.101	0.004	0.025	0.008	0.004	0.035	0.007	0.017	0.006	0.005	0.072	0.024	0.012	0.054	0.025	-2.172
Outside	0.013	0.006	0.203	0.018	0.014	0.026	0.275	0.035	0.004	0.109	0.007	0.032	0.010	0.008	0.037	0.009	0.021	0.012	0.008	0.060	0.023	0.016	0.067	0.025	0.037

Table A.3 – Case 1 – Simulation of the Italian excise sugar tax

product	brand	segm_label	diet	**tax_apply**	price	MC	MC_new	delta mc	pnew	delta P	delta P %	trasm	delta s	pcm	pcm_new
1	NB1	The	0	**1**	1.184	0.436	0.536	0.100	1.319	0.135	11.4%	1.351	-12.5%	0.75	0.78
2	NB10	The	0	**1**	0.942	0.412	0.512	0.100	1.069	0.128	13.5%	1.275	-13.4%	0.53	0.56
3	NB2	The	0	**1**	1.858	0.884	0.984	0.100	2.030	0.172	9.3%	1.722	-11.8%	0.97	1.05
4	NB4	The	0	**1**	0.926	0.380	0.480	0.100	1.052	0.126	13.7%	1.264	-13.3%	0.55	0.57
5	PLs	The	0	**1**	0.746	0.229	0.329	0.100	0.867	0.122	16.3%	1.217	-14.2%	0.52	0.54
6	NB2	The	1	**0**	1.848	0.880	0.880	0.000	1.793	-0.055	-3.0%		15.3%	0.97	0.91
7	NB1	Cola	0	**1**	1.261	0.488	0.588	0.100	1.398	0.137	10.9%	1.373	-12.2%	0.77	0.81
8	NB3	Cola	0	**1**	0.812	0.299	0.399	0.100	0.937	0.125	15.4%	1.252	-14.1%	0.51	0.54
9	PLs	Cola	0	**1**	0.453	0.027	0.127	0.100	0.619	0.166	36.6%	1.657	-15.9%	0.43	0.49
10	NB1	Cola	1	**0**	1.263	0.489	0.489	0.000	1.250	-0.013	-1.0%		12.4%	0.77	0.76
11	NB3	Cola	1	**0**	0.813	0.300	0.300	0.000	0.813	0.000	-0.1%		10.8%	0.51	0.51
12	NB1	Other_softdrnks	0	**1**	1.049	0.341	0.441	0.100	1.181	0.132	12.6%	1.318	-13.1%	0.71	0.74
13	NB1	Other_softdrnks	0	**0**	1.098	0.375	0.375	0.000	1.088	-0.010	-0.9%		12.2%	0.72	0.71
14	NB4	Other_softdrnks	0	**1**	0.571	0.094	0.194	0.100	0.692	0.121	21.3%	1.214	-15.8%	0.48	0.50
15	NB4	Other_softdrnks	0	**1**	1.275	0.641	0.741	0.100	1.408	0.133	10.4%	1.331	-11.4%	0.63	0.67
16	NB5	Other_softdrnks	0	**1**	1.108	0.532	0.632	0.100	1.237	0.130	11.7%	1.298	-12.3%	0.58	0.61
17	NB5	Other_softdrnks	0	**1**	1.121	0.542	0.642	0.100	1.251	0.130	11.6%	1.302	-12.2%	0.58	0.61
18	PLs	Other_softdrnks	0	**1**	0.534	0.056	0.156	0.100	0.653	0.119	22.4%	1.195	-15.7%	0.48	0.50
19	NB4	Other_softdrnks	1	**0**	0.828	0.303	0.303	0.000	0.827	-0.001	-0.2%		11.0%	0.52	0.52
20	NB9	Fruit drink	0	**1**	1.643	0.878	0.978	0.100	1.792	0.148	9.0%	1.484	-10.5%	0.77	0.81
21	NB8	Fruit drink	0	**1**	1.405	0.745	0.845	0.100	1.542	0.137	9.8%	1.371	-10.9%	0.66	0.70
22	NB7	Fruit drink	0	**1**	1.033	0.479	0.579	0.100	1.162	0.129	12.5%	1.286	-12.8%	0.55	0.58
23	PLs	Fruit drink	0	**1**	1.092	0.499	0.599	0.100	1.219	0.127	11.7%	1.272	-12.0%	0.59	0.62
24	NB6	Fruit drink	0	**1**	1.372	0.708	0.808	0.100	1.508	0.136	9.9%	1.361	-11.0%	0.66	0.70
25	NB6	Fruit drink	1	**0**	1.623	0.867	0.967	0.100	1.770	0.147	9.0%		-10.5%	0.76	0.80

Table A.4 – Case 1 – Effect of the Italian excise sugar tax: comparison with the baseline (no tax)

	LOW INCOME		**MIDDLE INCOME**		**HIGH INCOME**	
	NO CHILD	**CHILD**	**NO CHILD**	**CHILD**	**NO CHILD**	**CHILD**
			SSBs (L)			
	cohort 1	**cohort 2**	**cohort 3**	**cohort 4**	**cohort 5**	**cohort 6**
change in cons/year						
hh/year	-7.02	-7.80	-4.73	-5.53	-3.26	-4.63
person/year	-2.80	-2.02	-2.23	-1.55	-1.98	-1.35
% change wrt baseline	**-21.0%**	**-17.7%**	**-15.6%**	**-12.4%**	**-12.7%**	**-10.9%**
baseline cons/year						
per hh	33.4	44.1	30.3	44.7	25.7	42.3
per person	13.3	11.4	14.3	12.5	15.5	12.4
			tot sugar (gr)			
	cohort 1	**cohort 2**	**cohort 3**	**cohort 4**	**cohort 5**	**cohort 6**
change in cons/year						
hh/year	-768.92	-828.39	-523.38	-566.24	-361.73	-406.56
person/year	-307.05	-215.03	-247.12	-158.89	-219.13	-118.87
% change wrt baseline	**-27.6%**	**-22.0%**	**-21.4%**	**-15.2%**	**-18.4%**	**-13.1%**
baseline cons/year						
per hh	2787.2	3771.1	2448.5	3725.8	1967.3	3516
per person	1113.0	978.9	1156.1	1045.5	1191.7	1028
			added sugar (gr)			
	cohort 1	**cohort 2**	**cohort 3**	**cohort 4**	**cohort 5**	**cohort 6**
change in cons/year						
hh/year	-718.48	-758.39	-486.90	-516.13	-334.67	-406.56
person/year	-286.91	-196.86	-229.89	-144.83	-202.73	-118.87
% change wrt baseline	**-27.9%**	**-22.3%**	**-21.7%**	**-15.4%**	**-18.7%**	**-13.1%**
baseline cons/year						
per hh	2574.3	3403.1	2247.6	3345.2	1792.1	3104.6
per person	1028.0	883.4	1061.2	938.7	1085.6	907.7

Table A.5 – Case 2 – Simulation of the proportional excise tax

product	brand	segm_label	diet	**tax apply**	price	MC	MC new	delta mc	p new	delta P	delta P %	trasm	delta s	pcm	pcm new
1	NB1	The	0	**1**	1.184	0.436	0.514	0.078	1.285	0.101	8.5%	1.293	-6.6%	0.75	0.77
2	NB10	The	0	**1**	0.942	0.412	0.503	0.091	1.058	0.116	12.4%	1.276	-11.2%	0.53	0.56
3	NB2	The	0	**1**	1.858	0.884	0.985	0.101	2.032	0.174	9.4%	1.729	-11.9%	0.97	1.05
4	NB4	The	0	**1**	0.926	0.380	0.448	0.068	1.011	0.086	9.3%	1.261	-5.5%	0.55	0.56
5	PLs	The	0	**1**	0.746	0.229	0.315	0.086	0.850	0.104	14.0%	1.216	-10.5%	0.52	0.53
6	NB2	The	1	**0**	1.848	0.880	0.880	0.000	1.793	-0.055	-3.0%		15.4%	0.97	0.91
7	NB1	Cola	0	**1**	1.261	0.488	0.595	0.107	1.407	0.146	11.6%	1.370	-13.5%	0.77	0.81
8	NB3	Cola	0	**1**	0.812	0.299	0.385	0.086	0.920	0.108	13.3%	1.254	-10.5%	0.51	0.53
9	PLs	Cola	0	**1**	0.453	0.027	0.132	0.105	0.625	0.172	37.9%	1.640	-17.1%	0.43	0.49
10	NB1	Cola	1	**0**	1.263	0.489	0.489	0.000	1.249	-0.014	-1.1%		12.8%	0.77	0.76
11	NB3	Cola	1	**0**	0.813	0.300	0.300	0.000	0.814	0.000	0.0%		10.8%	0.51	0.51
12	NB1	Other_softdrnks	0	**1**	1.049	0.341	0.456	0.116	1.202	0.153	14.6%	1.324	-16.9%	0.71	0.75
13	NB1	Other_softdrnks	0	**0**	1.098	0.375	0.375	0.000	1.086	-0.012	-1.1%		12.7%	0.72	0.71
14	NB4	Other_softdrnks	0	**1**	0.571	0.094	0.148	0.054	0.637	0.067	11.7%	1.230	-3.7%	0.48	0.49
15	NB4	Other_softdrnks	0	**1**	1.275	0.641	0.743	0.102	1.412	0.137	10.7%	1.341	-11.9%	0.63	0.67
16	NB5	Other_softdrnks	0	**1**	1.108	0.532	0.632	0.100	1.237	0.130	11.7%	1.297	-12.2%	0.58	0.61
17	NB5	Other_softdrnks	0	**1**	1.121	0.542	0.653	0.111	1.266	0.145	12.9%	1.309	-14.7%	0.58	0.61
18	PLs	Other_softdrnks	0	**1**	0.534	0.056	0.155	0.100	0.653	0.119	22.3%	1.193	-15.5%	0.48	0.50
19	NB4	Other_softdrnks	1	**0**	0.828	0.303	0.303	0.000	0.828	0.000	0.0%		10.9%	0.52	0.52
20	NB9	Fruit drink	0	**1**	1.643	0.878	1.002	0.124	1.835	0.192	11.7%	1.549	-16.2%	0.77	0.83
21	NB8	Fruit drink	0	**1**	1.405	0.745	0.855	0.110	1.557	0.152	10.8%	1.385	-13.1%	0.66	0.70
22	NB7	Fruit drink	0	**1**	1.033	0.479	0.574	0.095	1.155	0.122	11.8%	1.286	-11.4%	0.55	0.58
23	PLs	Fruit drink	0	**1**	1.092	0.499	0.605	0.105	1.227	0.135	12.3%	1.277	-13.2%	0.59	0.62
24	NB6	Fruit drink	0	**1**	1.372	0.708	0.820	0.112	1.528	0.157	11.4%	1.398	-14.1%	0.66	0.71
25	NB6	Fruit drink	1	**0**	1.623	0.867	0.920	0.053	1.689	0.066	4.1%		0.7%	0.76	0.77

Table A.6 – Case 2 – Effects of the proportional excise tax: comparison with the baseline (no tax)

	LOW INCOME		MIDDLE INCOME		HIGH INCOME	
	NO CHILD	CHILD	NO CHILD	CHILD	NO CHILD	CHILD
			SSBs (L)			
	cohort 1	**cohort 2**	**cohort 3**	**cohort 4**	**cohort 5**	**cohort 6**
change in cons/year						
hh/year	-6.46	-7.38	-4.42	-5.31	-3.07	-4.49
person/year	-2.58	-1.91	-2.09	-1.49	-1.86	-1.31
% change wrt baseline	**-19.4%**	**-16.7%**	**-14.6%**	**-11.9%**	**-12.0%**	**-10.6%**
baseline cons/year						
per hh	33.4	44.1	30.3	44.7	25.7	42.3
per person	13.3	11.4	14.3	12.5	15.5	12.4
			tot sugar (gr)			
	cohort 1	**cohort 2**	**cohort 3**	**cohort 4**	**cohort 5**	**cohort 6**
change in cons/year						
hh/year	-752.17	-820.11	-517.64	-563.86	-358.80	-402.80
person/year	-300.37	-212.88	-244.41	-158.22	-217.35	-117.77
% change wrt baseline	**-27.0%**	**-21.7%**	**-21.1%**	**-15.1%**	**-18.2%**	**-13.0%**
baseline cons/year						
per hh	2787.2	3771.1	2448.5	3725.8	1967.3	3516
per person	1113.0	978.9	1156.1	1045.5	1191.7	1028
			added sugar (gr)			
	cohort 1	**cohort 2**	**cohort 3**	**cohort 4**	**cohort 5**	**cohort 6**
change in cons/year						
hh/year	-698.33	-744.35	-480.57	-510.44	-331.84	-402.80
person/year	-278.86	-193.21	-226.91	-143.23	-201.02	-117.77
% change wrt baseline	**-27.1%**	**-21.9%**	**-21.4%**	**-15.3%**	**-18.5%**	**-13.0%**
baseline cons/year						
per hh	2574.3	3403.1	2247.6	3345.2	1792.1	3104.6
per person	1028.0	883.4	1061.2	938.7	1085.6	907.7

Table A.7 – Case 2 – Simulation of the proportional excise tax + 20% reformulation: simulation strategy

product	brand	diet	segment label	av sug	av add_sug	tax apply	sugar ref	tax_apply ref	add_sug_REF
1	NB1	0	The	7.82	7.82	1	**6.25**	**1**	6.25
2	NB10	0	The	9.13	9.13	1	**7.30**	**1**	7.30
3	NB2	0	The	10.09	10.09	1	**8.07**	**1**	8.07
4	NB4	0	The	6.81	6.81	1	**5.45**	**1**	5.45
5	PLs	0	The	8.59	8.59	1	**6.87**	**1**	6.87
6	NB2	1	The	0.34	0.34	0	**0.34**	**0**	0.34
7	NB1	0	Cola	10.65	10.65	1	**8.52**	**1**	8.52
8	NB3	0	Cola	8.58	8.58	1	**6.86**	**1**	6.86
9	PLs	0	Cola	10.46	10.46	1	**8.36**	**1**	8.36
10	NB1	1	Cola	0.00	0.00	0	**0.00**	**0**	0.00
11	NB3	1	Cola	0.00	0.00	0	**0.00**	**0**	0.00
12	NB1	0	Other_softdrnks	11.57	10.18	1	**9.25**	**1**	8.14
13	NB1	0	Other_softdrnks	1.92	1.92	0	**1.92**	**0**	1.92
14	NB4	0	Other_softdrnks	5.41	5.41	1	**4.33**	**0**	4.33
15	NB4	0	Other_softdrnks	10.22	10.22	1	**8.17**	**1**	8.17
16	NB5	0	Other_softdrnks	10.00	10.00	1	**8.00**	**1**	8.00
17	NB5	0	Other_softdrnks	11.07	11.07	1	**8.86**	**1**	8.86
18	PLs	0	Other_softdrnks	9.96	9.96	1	**7.97**	**1**	7.97
19	NB4	1	Other_softdrnks	0.42	0.42	0	**0.42**	**0**	0.42
20	NB9	0	Fruit drink	12.39	5.98	1	**9.91**	**1**	4.78
21	NB8	0	Fruit drink	10.98	7.90	1	**8.78**	**1**	6.32
22	NB7	0	Fruit drink	9.47	6.66	1	**7.58**	**1**	5.32
23	PLs	0	Fruit drink	10.54	6.76	1	**8.43**	**1**	5.40
24	NB6	0	Fruit drink	11.22	7.82	1	**8.97**	**1**	6.26
25	NB6	1	Fruit drink	5.31	0.20	0	**4.25**	**0**	0.16

Table A.8 – Case 2 – Effects of the proportional excise tax + 20% reformulation: comparison with the baseline (no tax)

	LOW INCOME		**MIDDLE INCOME**		**HIGH INCOME**	
	NO CHILD	**CHILD**	**NO CHILD**	**CHILD**	**NO CHILD**	**CHILD**
			SSBs (L)			
	cohort 1	**cohort 2**	**cohort 3**	**cohort 4**	**cohort 5**	**cohort 6**
change in cons/year						
hh/year	-4.85	-5.80	-3.45	-4.37	-2.45	-3.68
person/year	-1.94	-1.51	-1.63	-1.23	-1.48	-1.08
% change wrt baseline	**-14.5%**	**-13.1%**	**-11.4%**	**-9.8%**	**-9.5%**	**-8.7%**
baseline cons/year						
per hh	33.4	44.1	30.3	44.7	25.7	42.3
per person	13.3	11.4	14.3	12.5	15.5	12.4
			tot sugar (gr)			
	cohort 1	**cohort 2**	**cohort 3**	**cohort 4**	**cohort 5**	**cohort 6**
change in cons/year						
hh/year	-1001.77	-1256.42	-800.69	-1102.53	-610.33	-874.09
person/year	-400.04	-326.13	-378.06	-309.38	-369.72	-255.56
% change wrt baseline	**-35.9%**	**-33.3%**	**-32.7%**	**-29.6%**	**-31.0%**	**-28.2%**
baseline cons/year						
per hh	2787.2	3771.1	2448.5	3725.8	1967.3	3516
per person	1113.0	978.9	1156.1	1045.5	1191.7	1028
			added sugar (gr)			
	cohort 1	**cohort 2**	**cohort 3**	**cohort 4**	**cohort 5**	**cohort 6**
change in cons/year						
hh/year	-925.33	-1135.70	-735.90	-989.87	-556.44	-874.09
person/year	-369.51	-294.80	-347.46	-277.77	-337.07	-255.56
% change wrt baseline	**-35.9%**	**-33.4%**	**-32.7%**	**-29.6%**	**-31.1%**	**-28.2%**
baseline cons/year						
per hh	2574.3	3403.1	2247.6	3345.2	1792.1	3104.6
per person	1028.0	883.4	1061.2	938.7	1085.6	907.7

Table A.9 – Case 3 – Simulation of the two-tier excise tax

product	brand	segm_label	diet	tax_apply	price	MC	MC_new	delta mc	pnew	delta P	delta P %	trasm	delta s	pcm	pcm_new
1	NB1	The	0	**1**	1.184	0.436	0.493	0.057	1.255	0.071	6.0%	1.243	-1.4%	0.75	0.76
2	NB10	The	0	**1**	0.942	0.412	0.518	0.106	1.077	0.135	14.4%	1.278	-14.7%	0.53	0.56
3	NB2	The	0	**1**	1.858	0.884	0.990	0.106	2.042	0.184	9.9%	1.738	-13.0%	0.97	1.05
4	NB4	The	0	**1**	0.926	0.380	0.437	0.057	0.997	0.072	7.7%	1.258	-2.7%	0.55	0.56
5	PLs	The	0	**1**	0.746	0.229	0.335	0.106	0.875	0.129	17.3%	1.218	-15.5%	0.52	0.54
6	NB2	The	1	**0**	1.848	0.880	0.880	0.000	1.791	-0.058	-3.1%		15.8%	0.97	0.91
7	NB1	Cola	0	**1**	1.261	0.488	0.594	0.106	1.407	0.146	11.6%	1.376	-13.4%	0.77	0.81
8	NB3	Cola	0	**1**	0.812	0.299	0.405	0.106	0.945	0.133	16.3%	1.251	-15.4%	0.51	0.54
9	PLs	Cola	0	**1**	0.453	0.027	0.133	0.106	0.626	0.173	38.1%	1.630	-17.3%	0.43	0.49
10	NB1	Cola	1	**0**	1.263	0.489	0.489	0.000	1.250	-0.013	-1.0%		12.7%	0.77	0.76
11	NB3	Cola	1	**0**	0.813	0.300	0.300	0.000	0.813	0.000	-0.1%		11.0%	0.51	0.51
12	NB1	Other_softdrnks	0	**1**	1.049	0.341	0.447	0.106	1.189	0.140	13.3%	1.319	-14.4%	0.71	0.74
13	NB1	Other_softdrnks	0	**0**	1.098	0.375	0.375	0.000	1.087	-0.011	-1.0%		12.6%	0.72	0.71
14	NB4	Other_softdrnks	0	**1**	0.571	0.094	0.151	0.057	0.641	0.070	12.3%	1.230	-4.4%	0.48	0.49
15	NB4	Other_softdrnks	0	**1**	1.275	0.641	0.747	0.106	1.418	0.143	11.2%	1.345	-12.7%	0.63	0.67
16	NB5	Other_softdrnks	0	**1**	1.108	0.532	0.638	0.106	1.245	0.138	12.4%	1.300	-13.5%	0.58	0.61
17	NB5	Other_softdrnks	0	**1**	1.121	0.542	0.648	0.106	1.259	0.138	12.4%	1.306	-13.5%	0.58	0.61
18	PLs	Other_softdrnks	0	**1**	0.534	0.056	0.162	0.106	0.660	0.126	23.7%	1.193	-17.1%	0.48	0.50
19	NB4	Other_softdrnks	1	**0**	0.828	0.303	0.303	0.000	0.827	-0.001	-0.1%		11.1%	0.52	0.52
20	NB9	Fruit drink	0	**1**	1.643	0.878	0.984	0.106	1.802	0.159	9.7%	1.497	-11.7%	0.77	0.82
21	NB8	Fruit drink	0	**1**	1.405	0.745	0.851	0.106	1.551	0.146	10.4%	1.379	-12.1%	0.66	0.70
22	NB7	Fruit drink	0	**1**	1.033	0.479	0.585	0.106	1.170	0.137	13.2%	1.289	-14.0%	0.55	0.58
23	PLs	Fruit drink	0	**1**	1.092	0.499	0.605	0.106	1.227	0.135	12.4%	1.273	-13.2%	0.59	0.62
24	NB6	Fruit drink	0	**1**	1.372	0.708	0.814	0.106	1.519	0.147	10.7%	1.387	-12.5%	0.66	0.70
25	NB6	Fruit drink	1	**0**	1.623	0.867	0.924	0.057	1.695	0.072	4.5%		-0.1%	0.76	0.77

Table A.10 – Case 3 – Effects of the two-tier excise tax: comparison with the baseline (no tax)

	LOW INCOME		**MIDDLE INCOME**		**HIGH INCOME**	
	NO CHILD	**CHILD**	NO CHILD	**CHILD**	NO CHILD	**CHILD**
			SSBs (L)			
	cohort 1	**cohort 2**	**cohort 3**	**cohort 4**	**cohort 5**	**cohort 6**
change in cons/year						
hh/year	-6.80	-7.68	-4.58	-5.42	-3.15	-4.59
person/year	-2.72	-1.99	-2.16	-1.52	-1.91	-1.34
% change wrt baseline	**-20.4%**	**-17.4%**	**-15.1%**	**-12.1%**	**-12.3%**	**-10.8%**
baseline cons/year						
per hh	33.4	44.1	30.3	44.7	25.7	42.3
per person	13.3	11.4	14.3	12.5	15.5	12.4
			tot sugar (gr)			
	cohort 1	**cohort 2**	**cohort 3**	**cohort 4**	**cohort 5**	**cohort 6**
change in cons/year						
hh/year	-778.99	-842.99	-529.74	-571.22	-364.80	-412.11
person/year	-311.08	-218.82	-250.12	-160.29	-220.99	-120.49
% change wrt baseline	**-27.9%**	**-22.4%**	**-21.6%**	**-15.3%**	**-18.5%**	**-13.3%**
baseline cons/year						
per hh	2787.2	3771.1	2448.5	3725.8	1967.3	3516
per person	1113.0	978.9	1156.1	1045.5	1191.7	1028
			added sugar (gr)			
	cohort 1	**cohort 2**	**cohort 3**	**cohort 4**	**cohort 5**	**cohort 6**
change in cons/year						
hh/year	-729.04	-772.73	-494.48	-521.10	-339.16	-412.11
person/year	-291.13	-200.58	-233.48	-146.22	-205.45	-120.49
% change wrt baseline	**-28.3%**	**-22.7%**	**-22.0%**	**-15.6%**	**-18.9%**	**-13.3%**
baseline cons/year						
per hh	2574.3	3403.1	2247.6	3345.2	1792.1	3104.6
per person	1028.0	883.4	1061.2	938.7	1085.6	907.7

Table A.11 – Case 3 – Simulation of the two-tier excise tax + 20% reformulation: simulation strategy

product	brand	diet	segm_label	av sugar (gr/100ml)	av add. sugar (gr/100ml)	tax_apply	sugar ref	**tax apply ref**	add_sugar ref
1	NB1	0	The	7.82	7.82	**1**	7.82	**1**	7.82
2	NB10	0	The	9.13	9.13	**1**	8.00	**1**	8.00
3	NB2	0	The	10.09	10.09	**1**	8.00	**1**	8.00
4	NB4	0	The	6.81	6.81	**0**	5.00	**0**	5.00
5	PLs	0	The	8.59	8.59	**1**	8.00	**1**	8.00
6	NB2	1	The	0.34	0.00	**0**	0.34	**0**	0.00
7	NB1	0	Cola	10.65	10.65	**1**	8.00	**1**	8.00
8	NB3	0	Cola	8.58	8.58	**1**	8.00	**1**	8.00
9	PLs	0	Cola	10.46	10.46	**1**	8.00	**1**	8.00
10	NB1	1	Cola	0.00	0.00	**0**	0.00	**0**	0.00
11	NB3	1	Cola	0.00	0.00	**0**	0.00	**0**	0.00
12	NB1	0	Other_softdrnks	11.57	10.18	**1**	11.57	**1**	10.18
13	NB1	0	Other_softdrnks	1.93	1.93	**0**	1.93	**0**	1.93
14	NB4	0	Other_softdrnks	5.41	5.41	**0**	5.00	**0**	5.00
15	NB4	0	Other_softdrnks	10.22	10.22	**1**	8.00	**1**	8.00
16	NB5	0	Other_softdrnks	10.00	10.00	**1**	8.00	**1**	8.00
17	NB5	0	Other_softdrnks	11.07	11.07	**1**	11.07	**1**	11.07
18	PLs	0	Other_softdrnks	9.96	9.96	**1**	8.00	**1**	8.00
19	NB4	1	Other_softdrnks	0.42	0.00	**0**	0.42	**0**	0.00
20	NB9	0	Fruit drink	12.39	5.98	**1**	12.39	**1**	6.41
21	NB8	0	Fruit drink	10.98	7.90	**1**	10.98	**1**	3.08
22	NB7	0	Fruit drink	9.47	6.66	**1**	8.00	**1**	5.61
23	PLs	0	Fruit drink	10.54	6.76	**1**	8.00	**1**	5.20
24	NB6	0	Fruit drink	11.22	7.82	**1**	11.22	**1**	3.39
25	NB6	1	Fruit drink	**5.31**	0.20	**0**	5.00	**0**	0.19

Table A.12 – Case 3 – Effects of the two-tier excise tax + 20% reformulation: comparison with the baseline (no tax)

	LOW INCOME		MIDDLE INCOME		HIGH INCOME	
	NO CHILD	**CHILD**	**NO CHILD**	**CHILD**	**NO CHILD**	**CHILD**
			SSBs (L)			
	cohort 1	**cohort 2**	**cohort 3**	**cohort 4**	**cohort 5**	**cohort 6**
change in cons/year						
hh/year	-6.80	-7.68	-4.58	-5.42	-3.15	-4.59
person/year	-2.72	-1.99	-2.16	-1.52	-1.91	-1.34
% change wrt baseline	**-20.4%**	**-17.4%**	**-15.1%**	**-12.1%**	**-12.3%**	**-10.8%**
baseline cons/year						
per hh	33.4	44.1	30.3	44.7	25.7	42.3
per person	13.3	11.4	14.3	12.5	15.5	12.4
			tot sugar (gr)			
	cohort 1	**cohort 2**	**cohort 3**	**cohort 4**	**cohort 5**	**cohort 6**
change in cons/year						
hh/year	-778.99	-842.99	-529.74	-571.22	-364.80	-412.11
person/year	-311.08	-218.82	-250.12	-160.29	-220.99	-120.49
% change wrt baseline	**-27.9%**	**-22.4%**	**-21.6%**	**-15.3%**	**-18.5%**	**-13.3%**
baseline cons/year						
per hh	2787.2	3771.1	2448.5	3725.8	1967.3	3516
per person	1113.0	978.9	1156.1	1045.5	1191.7	1028
			added sugar (gr)			
	cohort 1	**cohort 2**	**cohort 3**	**cohort 4**	**cohort 5**	**cohort 6**
change in cons/year						
hh/year	-729.04	-772.73	-494.48	-521.10	-339.16	-412.11
person/year	-291.13	-200.58	-233.48	-146.22	-205.45	-120.49
% change wrt baseline	**-28.3%**	**-22.7%**	**-22.0%**	**-15.6%**	**-18.9%**	**-13.3%**
baseline cons/year						
per hh	2574.3	3403.1	2247.6	3345.2	1792.1	3104.6
per person	1028.0	883.4	1061.2	938.7	1085.6	907.7

Table A.13 – Comparison across scenarios – supply effects

			Italian sugar tax (case 1)		proportional excise tax (case 2)		Two tier excise tax (case 3)		REF: proportional tax (case 2)		REF: Two tier tax (case 3)	
product	brand	diet	% change in price	% change in share	% change in price	% change in share	% change in price	% change in share	% change in price	% change in share	% change in price	% change in share
1	NB1	0	11.4%	-12.5%	8.8%	-6.8%	6.0%	-1.2%	8.2%	-6.1%	7.7%	-7.0%
2	NB10	0	13.5%	-13.4%	12.7%	-11.5%	14.4%	-15.5%	11.9%	-10.5%	9.4%	-8.2%
3	NB2	0	9.3%	-11.8%	9.7%	-12.3%	9.9%	-15.4%	10.3%	-14.0%	7.5%	-9.5%
4	NB4	0	13.7%	-13.3%	9.6%	-5.6%	7.7%	-2.5%	1.4%	8.1%	1.4%	6.1%
5	PLs	0	16.3%	-14.2%	14.4%	-10.8%	17.3%	-16.5%	12.8%	-8.9%	10.6%	-7.5%
6	NB2	1	-3.0%	15.3%	-3.1%	15.9%	-3.1%	18.9%	-1.0%	10.9%	-0.2%	7.6%
7	NB1	0	10.9%	-12.2%	11.9%	-13.9%	11.6%	-14.3%	10.8%	-12.1%	7.4%	-7.0%
8	NB3	0	15.4%	-14.1%	13.7%	-10.8%	16.3%	-16.5%	12.6%	-9.7%	10.4%	-8.3%
9	PLs	0	33.1%	-15.9%	35.1%	-17.6%	34.6%	-19.1%	31.4%	-14.2%	24.3%	-8.3%
10	NB1	1	-1.0%	12.4%	-1.1%	13.2%	-1.0%	14.2%	0.1%	10.1%	0.5%	7.3%
11	NB3	1	-0.1%	10.8%	0.0%	11.2%	-0.1%	12.4%	1.5%	8.1%	1.5%	6.1%
12	NB1	0	12.6%	-13.1%	15.0%	-17.3%	13.3%	-15.4%	13.1%	-14.3%	15.0%	-20.0%
13	NB1	0	-0.9%	12.2%	-1.1%	13.0%	-1.0%	13.9%	0.1%	10.3%	0.4%	7.6%
14	NB4	0	21.3%	-15.8%	12.0%	-3.8%	12.3%	-4.5%	2.0%	8.0%	2.0%	6.1%
15	NB4	0	10.4%	-11.4%	11.1%	-12.3%	11.2%	-13.4%	10.6%	-11.8%	7.6%	-7.6%
16	NB5	0	11.7%	-12.3%	12.1%	-12.5%	12.4%	-14.3%	11.3%	-11.5%	8.1%	-7.4%
17	NB5	0	11.6%	-12.2%	13.3%	-15.1%	12.4%	-14.2%	12.3%	-13.6%	14.2%	-19.3%
18	PLs	0	22.4%	-15.7%	22.9%	-16.0%	23.7%	-18.3%	19.8%	-12.9%	14.2%	-8.3%
19	NB4	1	-0.2%	11.0%	0.0%	11.3%	-0.1%	12.4%	1.5%	8.1%	1.5%	6.1%
20	NB9	0	9.0%	-10.5%	12.0%	-16.7%	9.7%	-12.4%	11.7%	-16.4%	12.7%	-20.4%
21	NB8	0	9.8%	-10.9%	11.2%	-13.5%	10.4%	-12.7%	10.7%	-13.1%	12.7%	-19.2%
22	NB7	0	12.5%	-12.8%	12.1%	-11.7%	13.2%	-14.8%	11.3%	-10.8%	8.6%	-7.7%
23	PLs	0	11.7%	-12.0%	12.7%	-13.6%	12.4%	-13.9%	11.5%	-11.8%	7.9%	-6.8%
24	NB6	0	9.9%	-11.0%	11.8%	-14.5%	10.7%	-13.2%	11.5%	-14.5%	13.1%	-19.8%
25	NB6	1	9.0%	-10.5%	4.2%	0.7%	4.5%	0.5%	0.9%	7.5%	1.0%	5.5%

Table A.14 – Comparison across scenarios – demand effects

	LOW INCOME		**MID INCOME**		**HIGH INCOME**		**LOW INCOME**		**MID INCOME**		**HIGH INCOME**		**LOW INCOME**		**MID INCOME**		**HIGH INCOME**	
	NO CH	**CHILD**	**NO CH**	**CHILD**	**NO CH**	**CHILD**	**NO CH**	**CHILD**	**NO CH**	**CHILD**	**NO CH**	**CHILD**	**NO CH**	**CHILD**	**NO CH**	**CHILD**	**NO CHD**	**CHILD**
	SSBs (L)						tot sugar (gr)						added sugar (gr)					
BASELINE	cohort 1	cohort 2	cohort 3	cohort 4	cohort 5	cohort 6	cohort 1	cohort 2	cohort 3	cohort 4	cohort 5	cohort 6	cohort 1	cohort 2	cohort 3	cohort 4	cohort 5	cohort 6
consumption/year																		
per household	33.4	44.1	30.3	44.7	25.7	42.3	2787	3771	2449	3726	1967	3516	2574	3403	2248	3345	1792	3105
per person	13.3	11.4	14.3	12.5	15.5	12.4	1113	979	1156	1045	1192	1028	1028	883	1061	939	1086	908
Italian sugar tax	cohort 1	cohort 2	cohort 3	cohort 4	cohort 5	cohort 6	cohort 1	cohort 2	cohort 3	cohort 4	cohort 5	cohort 6	cohort 1	cohort 2	cohort 3	cohort 4	cohort 5	cohort 6
change in cons/year																		
per household	-7.0	-7.8	-4.7	-5.5	-3.3	-4.6	-768.9	-828.4	-523.4	-566.2	-361.7	-406.6	-718	-758	-487	-516	-335	-407
per person	-2.8	-2.0	-2.2	-1.6	-2.0	-1.4	-307.1	-215.0	-247.1	-158.9	-219.1	-118.9	-287	-197	-230	-145	-203	-119
% change in cons	-21.0%	-17.7%	-15.6%	-12.4%	-12.7%	-10.9%	-27.6%	-22.0%	-21.4%	-15.2%	-18.4%	-13.1%	-27.9%	-22.3%	-21.7%	-15.4%	-18.7%	-13.1%
tax on sugar cont	cohort 1	cohort 2	cohort 3	cohort 4	cohort 5	cohort 6	cohort 1	cohort 2	cohort 3	cohort 4	cohort 5	cohort 6	cohort 1	cohort 2	cohort 3	cohort 4	cohort 5	cohort 6
change in cons/year																		
per household	-6.6	-7.6	-4.5	-5.5	-3.1	-4.6	-771.6	-841.3	-531.2	-578.9	-368.3	-413.3	-716.3	-763.5	-493.1	-524.0	-340.6	-413.3
per person	-2.6	-2.0	-2.1	-1.5	-1.9	-1.3	-308.1	-218.4	-250.8	-162.4	-223.1	-120.8	-286.0	-198.2	-232.8	-147.0	-206.3	-120.8
% change in cons	-19.8%	-17.2%	-15.0%	-12.2%	-12.3%	-10.9%	-27.7%	-22.3%	-21.7%	-15.5%	-18.7%	-13.3%	-27.8%	-22.4%	-21.9%	-15.7%	-19.0%	-13.3%
Two tier tax	cohort 1	cohort 2	cohort 3	cohort 4	cohort 5	cohort 6	cohort 1	cohort 2	cohort 3	cohort 4	cohort 5	cohort 6	cohort 1	cohort 2	cohort 3	cohort 4	cohort 5	cohort 6
change in cons/year																		
per household	-6.8	-7.7	-4.6	-5.4	-3.2	-4.6	-779.0	-843.0	-529.7	-571.2	-364.8	-412.1	-729.0	-772.7	-494.5	-521.1	-339.2	-412.1
per person	-2.7	-2.0	-2.2	-1.5	-1.9	-1.3	-311.1	-218.8	-250.1	-160.3	-221.0	-120.5	-291.1	-200.6	-233.5	-146.2	-205.5	-120.5
% change in cons	-20.4%	-17.4%	-15.1%	-12.1%	-12.3%	-10.8%	-27.9%	-22.4%	-21.6%	-15.3%	-18.5%	-13.3%	-28.3%	-22.7%	-22.0%	-15.6%	-18.9%	-13.3%
REFORMULATION SCENARIOS																		
Excise tax on sugar cont	cohort 1	cohort 2	cohort 3	cohort 4	cohort 5	cohort 6	cohort 1	cohort 2	cohort 3	cohort 4	cohort 5	cohort 6	cohort 1	cohort 2	cohort 3	cohort 4	cohort 5	cohort 6
change in cons/year																		
per household	-5.4	-6.4	-3.8	-4.8	-2.7	-4.1	-1067.6	-1330.0	-843.2	-1151.6	-638.6	-909.6	-986.8	-1204.1	-777.3	-1038.4	-585.5	-909.6
per person	-2.2	-1.7	-1.8	-1.4	-1.6	-1.2	-426.3	-345.2	-398.1	-323.1	-386.8	-265.9	-394.0	-312.5	-367.0	-291.4	-354.7	-265.9
% change in cons	-16.3%	-14.6%	-12.6%	-10.8%	-10.6%	-9.7%	-38.3%	-35.3%	-34.4%	-30.9%	-32.5%	-29.3%	-38.3%	-35.4%	-34.6%	-31.0%	-32.7%	-29.3%
Two tier tax	cohort 1	cohort 2	cohort 3	cohort 4	cohort 5	cohort 6	cohort 1	cohort 2	cohort 3	cohort 4	cohort 5	cohort 6	cohort 1	cohort 2	cohort 3	cohort 4	cohort 5	cohort 6
change in cons/year																		
per household	-4.50	-5.35	-3.19	-4.05	-2.31	-3.46	-906.1	-1120.8	-721.6	-956.3	-540.9	-815.1	-861.8	-1049.8	-705.0	-927.7	-534.9	-815.1
per person	-1.80	-1.39	-1.51	-1.14	-1.40	-1.01	-361.8	-290.9	-340.7	-268.3	-327.7	-238.3	-344.1	-272.5	-332.9	-260.3	-324.0	-238.3
% change in cons	-13.5%	-12.1%	-10.5%	-9.1%	-9.0%	-8.2%	-32.5%	-29.7%	-29.5%	-25.7%	-27.5%	-26.3%	-33.5%	-30.8%	-31.4%	-27.7%	-29.8%	-26.3%