Cross-country comparison of ex-ante sugar tax evaluations: Evidence from the biscuit, non-alcoholic beverage, and dairy dessert markets in France, Spain, and the United Kingdom *

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Abstract

Background: Excessive sugar consumption is associated with substantial health and economic burdens. Public policies aimed at reducing sugar intake, such as education campaigns and product labelling, have shown limited effectiveness, prompting growing interest in fiscal measures such as sugar taxes. While taxes on sugar-sweetened beverages have demonstrated reductions in consumption, evidence remains limited regarding their extension to other high-sugar products.
Objective: This study assesses the potential impacts of sugar taxation policies in France, the United Kingdom, and Spain on three key product categories that contribute substantially to sugar intake: non-alcoholic beverages, biscuits, and dairy desserts.
Method: Using nationally representative scanner data and a structural econometric model, we estimate demand, model firm pricing behavior under oligopolistic competition, and simulate the effects of a two-tiered sugar-based tax.
Results: Results indicate that firms generally over-shift the tax to prices, leading to significant reductions in purchases and sugar intake, with the largest impacts observed in non-alcoholic beverages and French dairy desserts. The tax is particularly effective among households with overweight or obese adults. Although consumer surplus and firm profits decline, these losses are outweighed by fiscal revenues and reductions in the social costs of excessive sugar intake.
Conclusions: Overall, our findings suggest that extending sugar taxes to other food and drink products can reduce sugar consumption and generate positive welfare effects. We then provide valuable evidence for policymakers considering broader fiscal measures to address diet-related health challenges.

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1 Introduction

The food sector has a crucial role in food security, but also weights major stakes such as ensuring healthy nutrition and managing the environmental impact of food production. The public health literature shows that excessive consumption of added sugars, particularly through sugar-sweetened beverages, is associated with several adverse health outcomes. Beyond its contribution to weight gain and obesity (Te Morenga et al., 2013; Wang et al., 2015), high sugar intake has been linked to an increased risk of type 2 diabetes, cardiovascular diseases, dental caries, and metabolic disorders (Malik et al., 2010; Imamura, 2015; Li et al., 2022; Huang, 2023; Janzi, 2024). These health burdens generate substantial costs for healthcare systems and society, providing a strong rationale for public policies aimed at reducing the consumption of products high in added sugars. Public authorities have implemented several kinds of policies, such as education campaigns to prevent abuse of added sugar, improvement of product labelling, and enhancement of nutrient consumption through collective agreements with manufacturers. Yet, despite some positive results, these measures have proved insufficiently effective (Brambila-Macias et al., 2011; Public Health England, 2020). In line with the World Health Organization (WHO), which recommends developing policies to limit the intake of products high in free sugars (World Health Organization, 2015), food taxes have been considered to address this issue more effectively (Roberto et al., 2019; Royo-Bordonada et al., 2019; Cawley et al., 2019; Lee et al., 2019; Pell et al., 2020, 2021). They have already been widely implemented for sugar-sweetened beverages (SSB), as they are one of the most important contributors to added sugar intake. In early 2020, more than 50 SSB taxes were already in force worldwide (Cawley et al., 2019). A systematic review shows that SSB taxes have actually been effective in reducing purchases of the targeted SSBs by an average of -15% through price increases (Andreyeva et al., 2022). A limitation of the existing measures is the narrowness of their scope, which only allows for small impacts on overall dietary intake (World Health Organization, 2022). Therefore, their extension to more unhealthy foods is considered by health authorities (World Health Organization, 2016; Department for Environment, Food and Rural Affairs, 2020; The Lancet Gastroenterology & Hepatology, 2020). However, they are less common for other products than SSB, even if they are increasingly adopted (from seven member States of the WHO in 2017 to 29 in 2022, World Health Organization, 2022). For example, non-essential foods with more than 275kcal/100g are taxed in Mexico (World Cancer Research Fund International, 2022), and products high in sugar, salt and/or caffeine are targeted by the "Public Health Product Tax" in Hungary (Biro, 2015; World Cancer Research Fund International, 2022). In 2023, Colombia introduced an excise tax on ultra-processed foods based on unhealthy nutrients (Burki, 2023).

However, little is known about the potential effect of a similar tax for products other than non-alcoholic beverages. The main objective of this study is to assess and compare the effects of a hypothetical tax scenario based on the UK's existing soda tax on variations in purchases and sugar consumption in the non-alcoholic beverage market, as well as in the biscuit and fresh dairy dessert markets. These three markets are major contributors to sugar intake across all age groups (children, adolescents and adults) (see Table 1). The study will be conducted in three different countries: Spain, France, and the United Kingdom (UK).

We use the UK Soft Drinks Industry Levy (SDIL), introduced by the UK government in 2018, as a policy-relevant reference design to assess the potential effects of extending sugar taxation beyond non-alcoholic beverages. The SDIL provides a relevant benchmark for our policy simulations because its two-tier structure links the tax burden to sugar content, with higher tax rates applied to high-sugar products and exemptions for products with relatively low sugar levels (see Appendix C.1 for details). In contrast, a uniform tax applied equally to all products would increase prices more uniformly and therefore provide weaker incentives for consumers to substitute towards healthier alternatives. Recent economic evidence from the SDIL confirms the effectiveness of sugar-content-based taxes. Using detailed scanner data, Dickson et al. (2025) show that beverages remaining above the tax thresholds experienced significant price increases, while purchases of these products declined substantially. The authors estimate that the levy reduced energy intake from soft drinks by around 6,600 kcal per person per year. Building on these observed changes, Cobiac et al. (2024) estimate that the SDIL contributed to meaningful improvements in health outcomes among children and adolescents, including reductions in obesity prevalence and dental caries. The authors also find that these health gains were concentrated among more socio-economically disadvantaged populations, suggesting that sugar taxes may contribute not only to improving population health but also to reducing health inequalities.

Table 1: Contribution of non-alcoholic beverages, biscuits, and dairy desserts to added-sugar intakes by age group in France, the UK, and Spain

	France *Sugar* (2014-2015)			**UK** *Added sugar* (2014-2016)			**Spain** *Added sugar* (2013)		
	Non alc. beverages	Biscuits	Dairy desserts	Non alc. beverages	Biscuits	Dairy desserts	Non alc. beverages	Biscuits	Dairy desserts
Children	14.5%	16.2%	13.7%	22.2%	8.7%	5.9%	24.5%	16.1%	18.0%
	(2nd)	(1st)	(3rd)	(2nd)	(4th)	(5th)	(1st)	(4th)	(3rd)
Adolescents	20.3%	16.3%	10.5%	32.7%	8.3%	2.5%	36.8%	13.1%	11.1%
	(1st)	(2nd)	(3rd)	(1st)	(3rd)	(8th)	(1st)	(3rd)	(5th)
Adults	13.8%	13.6%	9.7%	21.3%	7.1%	2.8%	28.4%	15.1%	11.9%
	(3rd)	(4th)	(5th)	(2nd)	(4th)	(8th)	(1st)	(3rd)	(5th)

Notes: This table shows the contribution of non-alcoholic beverages, biscuits, and dairy desserts to added-sugar or sugar intakes for children, adolescents and adults in France, the UK and Spain. The age groups are 1-10, 11-17 and 18-79 for France; 4-10, 11-18 and 19-64 for the UK; 9-12, 13-17 and 18-64 for Spain. The number in parentheses indicates the rank of the category. For France, the categories considered are "Soft drinks; Fruit and vegetables juices", "Pastries, cakes and biscuits", "Yoghurts and fromage frais; Entremets and dessert creams" (Anses, 2017; Dubuisson et al., 2019). For the UK, the categories considered are "Fruit juices; Soft drinks", "Biscuits", "Yoghurt, fromage frais and other dairy desserts" (Public Health England, 2018). For Spain, the categories considered are "Sugar soft drinks; Juices and nectars", "Bakery and pastries", "Yogurt and fermented milks; Other dairy products" (Ruiz et al., 2017).

To achieve this objective, we carry out ex-ante evaluations and comparisons of the effects of a sugar tax on the purchased quantity of non-alcoholic beverages, biscuits and dairy desserts by households in the UK, France, and Spain. Specifically, we apply a three-step structural econometric strategy, following Bonnet and Réquillart (2013). In a first step, we use scanner data purchases from France, the UK and Spain, which are nationally representative of their population, to estimate a discrete choice model of demand in each market allowing for substitutions between varieties of products. We represent consumer preferences using a Random Coefficient Logit model (McFadden and Train, 2000), controlling for the endogeneity of prices (Petrin and Train, 2010). This estimation approach identifies household-specific preference parameters and the demand curves for the varieties of biscuits, non-alcoholic beverages or dairy desserts in the three countries. In a second step, we model the supply side as an oligopoly proposing differentiated products and competing *à la Nash* in a Bertrand game, in the spirit of Berry et al. (1995) and Nevo (2001). This step allows for the consideration of the pricing strategy responses of firms facing taxes. As shown by Bonnet and Réquillart (2013), the firms' price response to tax depends on the competitive environment of the market and can influence the effectiveness of such policies in reducing consumption. We use estimated demand curves and the supply model to identify price-cost margins and unit production costs for each product. Using these models, we simulate the effect of a tax on each market by modelling how firms' prices and consumers' purchases would react to the tax. Here, we simulate the impact of a two-tiered, sugar-based tax, as implemented in the UK's non-alcoholic beverage market. Our findings show that, in each market and country, firms generally pass on more than the amount of tax, which results in a reduction in purchases and sugar intake. The tax is most efficient in the non-alcoholic beverage market in the three countries, in the French dairy dessert market, and among households where all the adults are overweight or obese. Reducing sugar intake would impact society as a whole. The introduction of these taxes reduces both consumer surplus and firm profits. However, these losses may be offset by the health-related social benefits they generate. When accounting for consumer surplus, firm profits, fiscal revenue, and the social costs of excessive sugar consumption, we find an overall positive effect on total welfare.

Our analysis contributes to the current debate on food taxes by assessing the impact of a sugar tax on three different food markets in three different countries. We provide a global welfare analysis of this fiscal tool, taking into account its social costs and benefits, which could be useful for policymakers.

The paper is organised as follows. Section 2 provides a brief overview of the method, covering the data that was used and the empirical strategy. Section 3 presents the results of the demand and supply model, while Section 4 presents the results of the counterfactual analysis. Finally, Section 5 discusses the policy implications of the study, and Section 6 concludes.

2 Methods

2.1 Data

We use representative consumer panel data from Kantar Worldpanel from 2017 for France, the UK and Spain. The consumer panels of Kantar Worldpanel comprise 19,679 households in France, 24,586 households in the UK, and 7,887 households in Spain. Households in Catalonia, where a regional soft drink tax was introduced in May 2017, are excluded from the analysis to ensure a homogeneous sample of Spanish households with respect to tax exposure. The data contains daily home-scan records of food purchases from three distinct markets: non-alcoholic beverages, biscuits, and dairy desserts. The datasets contain household information such as income, household composition, and the height and weight of each household member, as well as product characteristics such as brand, size, quantity, price, sugar and fat content.

Market definitions. Table A.1 provides a description of the products included in each market. Non-alcoholic beverages markets: We include sugar-sweetened beverages, fruit juices and flavoured waters in the three countries. In the UK market, we also include milk-based drinks (e.g., flavoured milk) because they form part of children's diets. We exclude water and products that are not ready to drink (e.g., syrup, powdered drinks and cocktail mixers).
Biscuits markets: Following the Kantar food classification, we exclude sweets, chocolate tablets and chocolate bars from our analysis for the three countries. They are not close substitutes for biscuits, as illustrated by their location in supermarkets, where they are generally not found in the same aisle as biscuits. The only exception is UK chocolate bars smaller than two fingers, which are categorised as biscuits in the UK's childhood obesity plan (Public Health England, 2016).
Desserts markets: This includes yoghurts and other dairy desserts (ODDs) for the three countries, as well as fromage blanc and petits suisses (FBPSs) for France and the UK. The latter items are categorised as ODD in Spain, as they account for only a very small proportion of the Spanish dairy desserts market.

Demographics characteristics. Households are categorised according to three criteria. First, we create dummy variables to indicate whether there are children under six or between seven and 16 years old in the household. Secondly, we define the household's obesity status using the proportion of obese or overweight adults in the household. Adults with a body mass index (BMI) above 30 are considered obese, while those with a BMI between 25 and 30 are considered overweight. Thirdly, we define the socio-economic class of the household. The definition of the socio-economic class variable differs across the three databases. In France, it is based on monthly income and household size; in the UK, it is based on socio-professional categories; and in Spain, it is based on level of education and employment situation. However, we assume that the ranking of households within a country remains consistent regardless of the socio-economic class criteria used. Descriptive statistics of the sample are provided in Table A.2.

Product definition. We define the range of products available to households in each market and country as a combination of product attributes. We split each market into sub-categories (detailed in Tables A.3, A.4 and A.5). We have information on the firm and the brand of the product (see Table A.6 for details about the market structure). We also use the sugar content information provided in the British and Spanish panels. For France, due to the unavailability of this information in the dataset, nutritional data were obtained from the French Food Observatory (Oqali) and supplemented with additional information on product composition from brand websites and the Open Food Facts database (Open Food Facts, 2012). In all three countries, we identify products containing added sugar.

Non-alcoholic beverages markets: The definition of the differentiated products is based on information such as the firm and brand name, the drinks subcategory and other product characteristics (e.g., whether the SSB is diet or regular and whether the fruit juice contains added sugar and its flavour). Following this product differentiation, we obtain 319, 402 and 285 distinct beverage varieties (hereafter referred to as "alternatives") in France, the UK and Spain, respectively.

Biscuits: We define an alternative based on the subcategory, firm and brand names, and the flavour of the biscuit (e.g. chocolate or vanilla). Combining these characteristics results in 407 alternatives in France, 500 in the UK, and 309 in Spain.

Desserts: The definition of differentiated products is based on information relating to subcategories, firm and brand names, and other product characteristics (e.g., plant-based ingredients instead of dairy milk, fat content, and the presence of sweeteners). This yields 266 alternatives in France, 171 in the UK, and 281 in Spain.

Further information on the definition of subcategories, the identification of the presence of added sugars in products, and the construction of the differentiated products and prices is provided in Appendix A.1. We also present some descriptive statistics on the market structure and prices for each market and each country in this appendix.

2.2 Descriptive statistics

Figure 1 displays the distribution of household purchases in panel A and the distribution of sugar content in panel B for the three countries and three markets.

We can see that the proportion of households with high non-alcoholic beverage consumption is substantially higher in the UK than in other countries. In the UK, 14.5% of households consume more than 330 ml per capita per day (the equivalent of one can), compared to 6.7% in France and 5.3% in Spain. Household distribution seems more homogeneous between countries in the biscuit market, where 4.2% of French households, 5.6% of UK households, and 3.3% of Spanish households consume more than 40 g of biscuits per capita per day (roughly equivalent to one biscuit). The proportion of French households purchasing more than 125 g of dairy desserts per capita per day (the equivalent of a standard-size yogurt) is 17.8%, which is much higher than the corresponding proportion of UK households (1.6%) and Spanish households (4.5%).

The distribution of sugar content in beverages is denser around 10 grams of sugar per 100 grams of product, especially in the French market. The British and Spanish beverage markets offer more products with a low sugar content than the French market. Biscuits are mainly distributed at around 30 g of sugar per 100 g of product, although biscuits on the Spanish market are substantially less concentrated than in the other two countries. Dairy desserts are mainly distributed at around 13 g of sugar per 100 g of product in France and Spain and at around 11–12 g per 100 g in the UK. However, the distribution is also quite dense around 4–6 g of sugar per 100 g of product in France and Spain and to a lesser extent in the UK. This part of the distribution corresponds to products without added sugar, such as plain yogurts.

Table A.7 provides information on sugar consumption of non-alcoholic beverages, biscuits and dairy desserts, overall and by household characteristics. Our dataset reveals that non-alcoholic beverages account for the greatest sugar intake, which justifies the introduction of a sugar tax in this market: France (since 2012), Catalonia (since 2017) and the UK (since 2018). Of these three markets, France has the highest sugar intake from non-alcoholic beverages and dairy desserts. Although UK households purchase larger quantities of beverages than French households (Figure 1, Panel A), the higher sugar content of products in France (Figure 1, Panel B) offsets this difference, resulting in a higher sugar intake from this sector in France. We also observe high sugar consumption from dairy desserts in France. This is due to high consumption of these products, as well as their high sugar content (Figure 1).

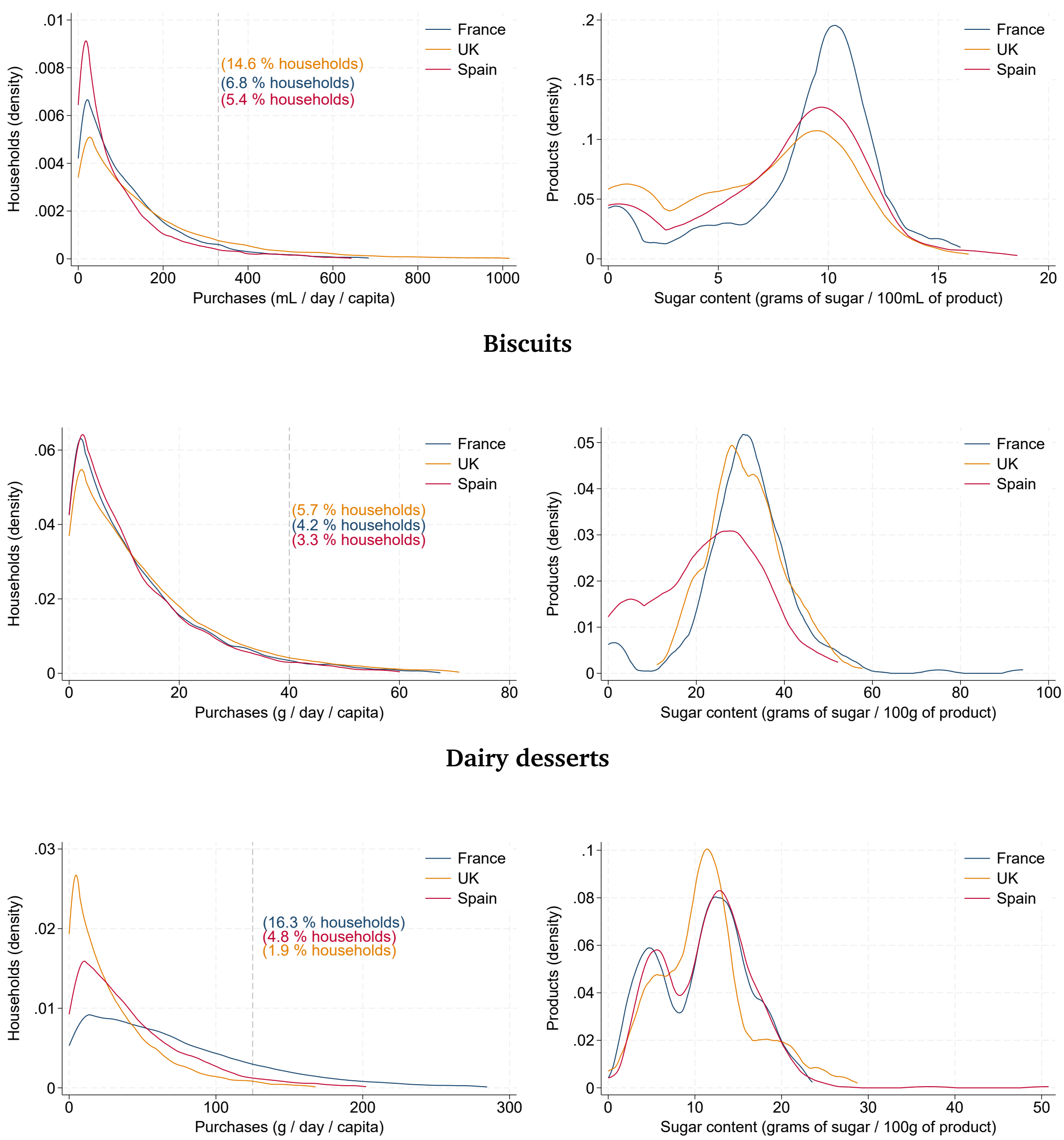
Disaggregating sugar consumption by household characteristics reveals that poor households consume more sugar from non-alcoholic beverages in all three countries and from biscuits in France and the UK, and from dairy desserts in Spain (see Table A.7). Households in which all members are overweight or obese have the highest sugar consumption in all nine markets. Households with children aged 7–16 consume more sugar from non-alcoholic beverages and biscuits in all countries. However, the results are more mixed in the dairy desserts market, depending on the age of the children in the household.

Figure 1: Descriptive statistics

Purchases across households | **Sugar content across products**

Panel A | **Panel B**

Beverages



Notes: Panel A: Distribution of quantities purchased by households in France, the UK and Spain. For the non-alcoholic market (first panel), quantities are expressed in millilitres (mL) per day per capita, and the 330 mL threshold corresponds to the size of a standard can. For the biscuit market (second panel), quantities are expressed in grams per day per capita and the 40-gram threshold corresponds to one standard biscuit. For the fresh dessert market (third panel), quantities are expressed in grams per day per capita and the 125-gram threshold corresponds to a standard yogurt. The 99th percentile is excluded when plotting the graphs. Panel B: Distribution of the sugar content across defined alternatives that represent the products available on each market in France, the UK and Spain. The x-axis is expressed in grams of sugar per 100 grams of product.

2.3 Empirical strategy

We develop a structural econometric model of demand and supply to analyse consumer choices and firm pricing strategies in response to taxation. We use a flexible discrete-choice framework combined with a supply model that assumes oligopolistic competition between firms. The estimation of the impact of the tax involves three steps, as described in Bonnet and Réquillart (2013).

First, separate demand models are estimated for non-alcoholic beverages, biscuits and dairy desserts, in order to analyse household purchases for each country. Using a random coefficient logit framework, we estimate preferences for product characteristics and derive price elasticities, i.e., how households adjust their purchases in response to a price change (see Appendix B.1 for details).

Second, using the estimated consumer substitution parameters, we model the supply side to analyse strategic pricing decisions, i.e., how firms set their prices, and determine the marginal costs of alternatives (see Appendix B.2 for details).

Lastly, we use the estimated demand and supply model to conduct a counterfactual simulation and assess the impact of a two-tiered sugar tax, equivalent to the SDIL design, in each market and country. The SDIL is a two-tier specific tax, introduced in 2018, that exempts products below a first sugar threshold and applies increasing tax rates above two sugar-content thresholds. To ensure comparability across countries and product categories, we do not directly transpose the UK thresholds (5 and 8 g of sugar per 100 ml) to all markets. Instead, we construct an equivalent two-tier tax based on the distribution of sugar content within each market, defined as a country–product category combination. Specifically, the first and second thresholds are set at the 35th and 61st percentiles of the sugar-content distribution in each market, corresponding to the relative positions of the SDIL thresholds in the UK soft-drink market. Tax rates are then scaled according to the average product price in each market so that the fiscal burden remains comparable to that generated by the SDIL (see Appendix C for details). Table 2 reports the resulting thresholds and tax levels for each market. Table 2 summarises, for the nine scenarios, the location of the two sugar content thresholds (in grams of sugar per 100 g or mL of products), and the two tax amounts applied at these thresholds (see Appendix C.2 and Appendix C.3 for details on how we determine them based on the characteristics and the tax design of the UK beverage market). For example, in the French biscuit market, products containing less than 29 g of sugar per 100 g are exempt from the tax; those containing 29–33 g are taxed at 1.94€/kg; and those with more than 33 g are taxed at 2.59€/kg. Implementing a tax affects the marginal cost of products. We estimate the resulting new price equilibrium from this additional marginal cost based on the supply and demand model (see Appendix C.4 for details). Depending on the behavior of households and the level of competition, firms can pass on more or less of the tax. The pass-through rate of the tax is crucial, as it affects the change in consumption. This methodology allows us to study the impact of taxes on the market, including the transmission of taxes and changes in prices, as well as its consequences for diet, such as changes in consumption and sugar intake.

To provide a welfare analysis of the tax scenario, we compute the variation in consumer surplus, firm profit, fiscal revenue and social cost of excessive sugar consumption in all markets and countries. We refer to the expressions described in Appendix C.5.

Table 2: Tax scenarios

	Sugar thresholds (g / 100 g or ml)	**Tax amount (€ / kg or L)**
Non-alcoholic beverages		
UK	[5 ; 8]	[0.21 ; 0.28]
France	[8 ; 10]	[0.33 ; 0.43]
Spain	[8 ; 10]	[0.26 ; 0.35]
Biscuits		
UK	[27 ; 33]	[1.38 ; 1.84]
France	[29 ; 33]	[1.94 ; 2.59]
Spain	[20 ; 28]	[1.05 ; 1.41]
Dairy desserts		
UK	[11 ; 13]	[0.96 ; 1.28]
France	[12 ; 14]	[0.79 ; 1.05]
Spain	[11 ; 13]	[0.69 ; 0.92]

Notes: This table presents the two-tiered taxes implemented in the counterfactual analyses for each market and each country. The first column shows the location of the two thresholds (in grams of sugar per 100 g or mL). The second column displays the tax amount (in euros per kg or L) at each threshold. Details on the counterfactual calibrations are provided in Appendices C.2 and C.3.

3 Results of the demand and supply model

3.1 Demand estimates

The estimates from the demand model on the non-alcoholic beverage, biscuit and dairy dessert markets are presented in Tables B.5, B.6 and B.7, respectively. In every market, country and population, price has a significant negative impact on utility. Unobserved heterogeneity in price disutility is also substantial in every case. We found that obesity status plays a role. When households are composed of overweight or obese adults, they are more price sensitive in the non-alcoholic beverage market, except when all Spanish adults are overweight or obese where there is no additional effect on price sensitivity. Conversely, a weak difference in price sensitivity in the biscuit and dairy dessert markets is observed according to the obesity status. Households in lower socio-economic classes are more price-sensitive than those in higher classes in every market and country, except for the French dairy dessert market. The presence of children also affects price sensitivity, but this varies by market and country.

In terms of product characteristics, British households, especially those with children, display a stronger preference for diet products in the non-alcoholic beverage market. This is not the case for Spanish and French households. In all three markets, households prefer products with more sugar, except for French households in the non-alcoholic beverage market. Households with children have a stronger preference for sugary products in all three countries. In the biscuit and dairy dessert markets, households prefer fatty products.

The brand fixed effect parameter estimates (not displayed in the tables) are larger than the other preference parameter estimates, suggesting high brand loyalty. The positive and significant error terms of the price equation (see subsection B.1.2) indicate that the unobserved factors influencing prices encourage the purchase of alternatives.

3.2 Elasticities and margins

Table B.11 shows the own-price elasticities of non-alcoholic beverages, biscuits, and dairy desserts, categorised by household composition, obesity status, and socio-economic class. We find that demand for non-alcoholic beverages is the most elastic, whereas demand for dairy desserts is the least elastic, in all three countries. We also observe some heterogeneity across demographics. Household composition and obesity status affect own-price elasticity, but there is no common trend. As expected, we observe that poor households have the most price-elastic demand, while rich households have the least. However, no heterogeneity is observed according to socio-economic class in the French dairy dessert market.

Tables B.8, B.9 and B.10 show the own-price elasticities and firm margins by category for beverages and dairy desserts, and by sugar content level for biscuits. We observe that the heterogeneity across product categories is more important than the heterogeneity across household demographics. Margins for firms are highly heterogeneous between categories of non-alcoholic beverages in every country, ranging from 15.9% of the price for energy drinks to 53.2% for lemonades in the UK, for example. Substantial heterogeneity is also displayed in the biscuit market, ranging from 26.9% of the price for biscuits with a sugar content below 10 g per 100 g of product to 60.1% of the price for biscuits with a sugar content between 31 and 37 g per 100 g of product in France. In the dairy desserts market, however, firm margins are less heterogeneous between categories, ranging from 34.8% for ODD to 55.7% for plain yogurts in France. Within the same market, firm margins also vary between countries. Margins in the UK market are, on average, lower than in France and Spain.

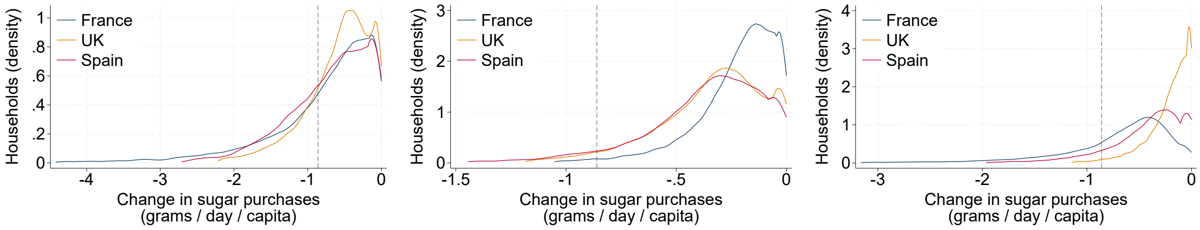
4 Counterfactual experiment

Using the model of consumers' and firms' behaviors, we assess the impact of a sugar tax on each market and country. The tax scenarios are presented in Table 2 for each market and each country.

Figure 2 illustrates the impact of the tax on sugar purchases across households. When we compare markets, we can see that the tax on non-alcoholic beverages has led to a greater decrease in sugar consumption than in the other markets, with the French dairy dessert market following closely behind. This is primarily due to higher initial sugar intake from non-alcoholic beverages in the three countries (Table A.7) and higher elasticities (Table B.11). The results for dairy desserts in France are mainly due to large initial purchases. When comparing countries, taxes are more efficient in France, except for the biscuit market, where taxes in Spain and the UK appear to reduce sugar consumption more effectively. On average, the daily effect on sugar intake is small. The average reduction ranges from 0.24 g/day/capita in the UK dairy desserts market (a 7% reduction) to 0.86 g/day/capita in the French non-alcoholic beverages market (a 9% reduction) (Table 3). The largest variation in sugar intake is observed in the Spanish biscuit market, where the average reduction is 0.40 g/day/capita, corresponding to a 15% decrease from an initial consumption of 2.65 g/day/capita. However, the distribution depicted in Figure 2 shows that the proportion of the population reducing their sugar intake by one teaspoon, equivalent to 6 grams of sugar per week, is 1.3%, 11.3% and 26.2% for the British, Spanish and French dairy dessert markets, 3.8%, 5.9% and 1.0% for the British, Spanish and French biscuit markets, and 21.6%, 32.2% and 32.6% for the British, Spanish and French non-alcoholic beverage markets, respectively.

Figure 2: Variation in sugar purchases across households

(a) Beverages **(b) Biscuits** **(c) Dairy desserts**

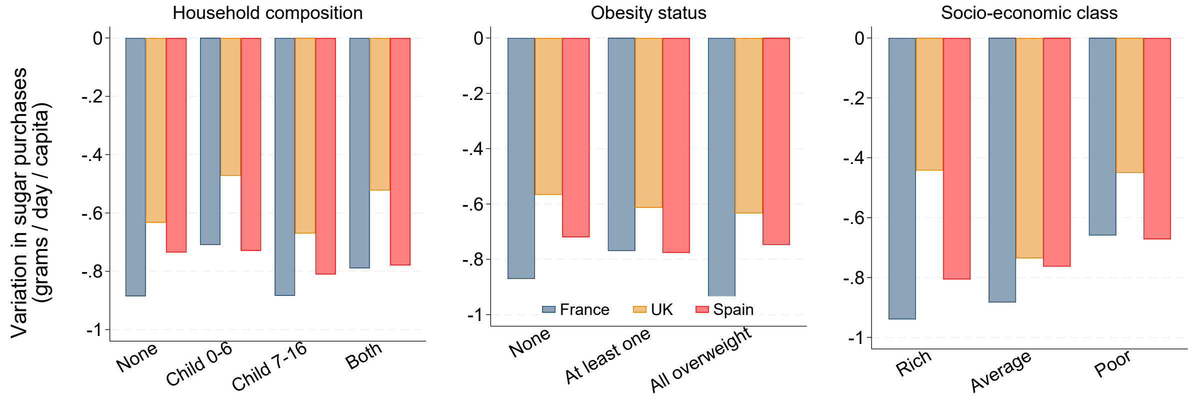


Notes: These figures plot the distributions of the variation in sugar purchases across households in the panel following the implementation of the tax. The distribution is computed across households in the panel. The variation (x-axis) is expressed in grams of sugar per day per capita. The vertical dashed line indicates the equivalent of one sugar cube per week per capita (= 0.86 grams per day per capita). The first and last percentiles have been dropped for each distribution.

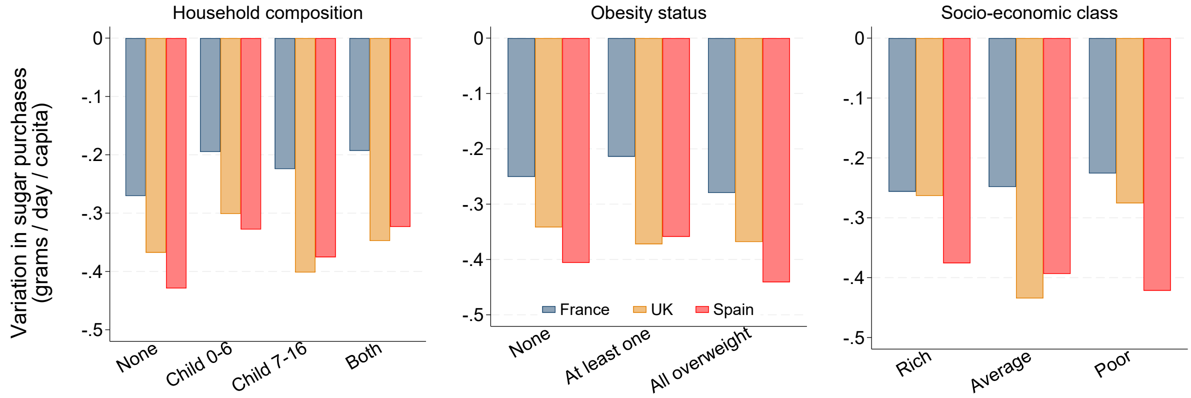
Figure 3 shows how sugar purchases vary by demographic group. Since the differences in own-price elasticities by demographic group are quite small (Table B.11), variations in sugar purchases largely depend on the initial sugar purchases of each group. The greatest variation in sugar purchases is seen among households without children in all markets in France. In the UK and Spain (except for the biscuit market), the variation is greater for households with a child aged 7–16. In France, the variations are higher for wealthy households and lower for poorer households, which can be explained by differences in price elasticity and initial purchase levels. In the UK, households in the middle socio-economic class depict the highest reduction. In Spain, the results according to socio-economic class are more mixed, with rich households reducing their sugar purchases more from the beverage and dairy dessert markets and less from the biscuit market. We also observe that, globally, households comprising all overweight or obese adults reduce their sugar purchases the most, regardless of the market or country. However, there is an exception in the Spanish beverage market, where the difference according to obesity status is weak.

Figure 3: Variation in sugar purchases by demographics

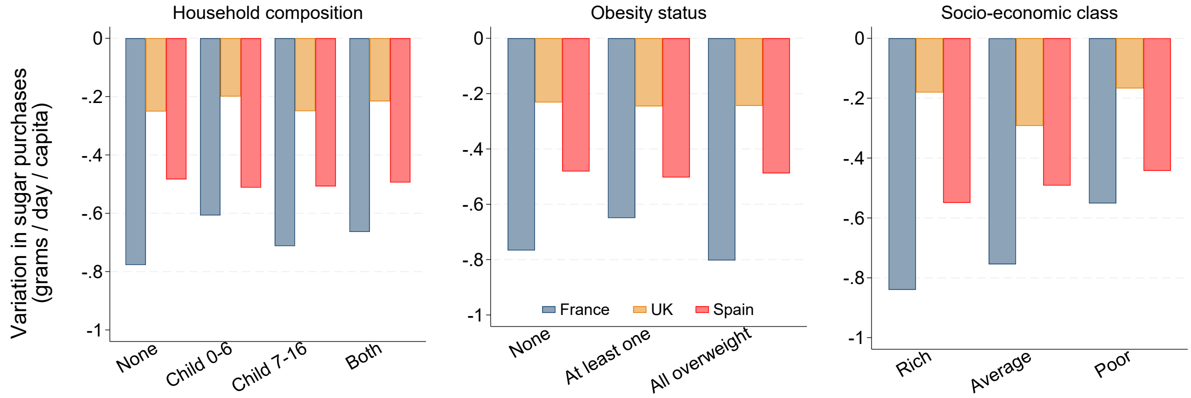
(a) Beverages



(b) Biscuits



(c) Dairy desserts



Notes: These figures plot the average variation in sugar purchases by demographics following the implementation of the tax. The variation is expressed in grams of sugar per day per capita. The left panel represents the household composition and the categories are "no children", "at least one child between 0 and 6 years old", "at least one child between 7 and 16 years old", "at least one child between 0 and 6 years old and one child between 7 and 16 years old". The middle panel represents the obesity status of the household and the categories are "no overweight nor obese adult ", "at least one overweight or obese adult", "all overweight or obese adults". The right panel represents the socio-economic class of the household and the categories are "rich", "middle" and "poor".

Table 3: Summary of the sugar tax simulations

	France	UK	Spain
Beverages			
Outside option (pp)	+1.05	+0.16	+1.67
	+49.5%	+11.3%	+60.6%
Pass-through (mean)	1.08	1.01	1.11
[p5;p95]	[0.99;1.15]	[1.00;1.01]	[0.99;1.39]
Sugar intake (in g/day/capita)	-0.86	-0.61	-0.75
Variations (in million €)			
Consumer surplus	-39.2	-9.6	-9.8
Profit	-0.2	-0.7	-0.1
Tax revenue	+23.5	+5.8	+4.1
Sugar social cost	-49.3	-62.1	-39.2
Total welfare			
without health benefits	-15.9	-4.5	-5.8
with health benefits	+33.4	+57.5	+33.5
Biscuits			
Outside option (pp)	+7.69	+8.33	+10.16
	+75.9%	+99.1%	+43.0%
Pass-through (mean)	1.09	1.00	1.04
[p5;p95]	[0.97;1.17]	[0.99;1.01]	[0.92;1.07]
Sugar intake (in g/day/capita)	-0.25	-0.36	-0.40
Variations (in million €)			
Consumer surplus	-48.0	-20.3	-9.7
Profit	-11.7	-1.8	-4.0
Tax Revenue	+35.4	+9.4	+6.4
Sugar social cost	-24.2	-31.3	-14.8
Total welfare			
without health benefits	-24.3	-12.7	-7.2
with health benefits	-0.1	+18.6	+7.6
Dairy desserts			
Outside option (pp)	+0.91	+1.45	+0.66
	+78.82	+73.9%	+121.1%
Pass-through (mean)	1.01	1.01	1.03
[p5;p95]	[0.98;1.03]	[0.96;1.04]	[0.91;1.12]
Sugar intake (in g/day/capita)	-0.74	-0.24	-0.49
Variations (in million €)			
Consumer surplus	-79.4	-28.9	-17.2
Profit	-2.4	-1.7	-2.9
Tax revenue	+54.4	+17.5	+7.6
Sugar social cost	-87.6	-19.9	-34.6
Total welfare			
without health benefits	-27.4	-13.0	-12.5
with health benefits	+60.2	+6.9	+22.1

Notes: This table summarizes the results of the sugar tax simulations: variation of the outside option (in percentage points and in percentage); average pass-through (and 5th and 95th percentiles); variation in sugar intake (in grams per day per capita); variations in million € of the consumer surplus, profit, rax revenue, sugar social cost and total welfare (which is the sum of profit, consumer surplus and fiscal revenue variations). Health benefits are computed with the social cost of sugar estimated at 12.833 € per kg of sugar consumed by Seidel et al. (2023), using data from Institute for Health Metrics and Evaluation (2022), Lara Castor et al. (2024), and von Philipsborn et al. (2023). Formulas are provided in Appendix C.5.

Table 3 shows the impact of the tax on various market indicators. The outside option, representing non-purchase behavior by households, increases significantly in all countries and markets. This ranges from +11% in the UK's non-alcoholic beverages market to +99.1% in the UK's biscuits market. This indicates a significant reduction in the total market share of the alternatives considered in each market and country. This decrease is explained by the increase in price due to the full passing on of the tax, as well as the price sensitivity of consumers. Indeed, the pass-through is greater than one on average for all markets and countries. However, there is some heterogeneity, with the pass-through being below one for certain products, meaning that firms can absorb some of the tax to avoid excessive losses.

5 Discussion

Our analysis shows that introducing a sugar tax in France, Spain and the UK would reduce sugar intake from non-alcoholic beverages, biscuits and dairy desserts. However, this reduction would not be without impact on society. Firstly, governments could earn fiscal revenue to cover health costs due to excess sugar consumption, or implement additional policies to help reduce sugar consumption further. According to Table 3, the simulated increases in tax revenues amount to 4.1, 5.8 and 23.5 million euros for non-alcoholic beverages; 6.4, 9.4 and 35.4 million euros for biscuits; and 7.6, 17.5 and 54.4 million euros for dairy desserts, in Spain, the UK and France, respectively.

However, consumers and firms would be affected by the introduction of these taxes. We estimate that the annual variation in consumer surplus ranges from -9.6 million euros in the UK non-alcoholic beverage market to -79.4 million euros in the French dairy desserts market. Our results also suggest that firms' annual losses are smaller and could range from 0.1 million euros in the Spanish non-alcoholic beverage market to 11.7 million euros in the French biscuit market. These decreases in economic welfare could be offset by reductions in social costs resulting from health benefits associated with the tax. Assuming a value of 12.8 € per kg for the social cost of sugar, estimated by Seidel et al. (2023) using data from Institute for Health Metrics and Evaluation (2022), Lara Castor et al. (2024), and von Philipsborn et al. (2023), we estimate the economic gain due to health benefits to be on the order of tens of millions of euros. After summing all the costs and benefits induced by the tax, we observe positive total welfare for all markets and countries except the French biscuit market (-100,000 euros). This total welfare analysis is important for policymakers as it shows that the health benefits can more than compensate for the losses of consumers and firms.

Our results are broadly consistent with the evidence reported by Dickson et al. (2025) for the

UK Soft Drinks Industry Levy. They estimate that around 80% of the reduction in sugar purchases is attributable to product reformulation, while the remaining 20% reflects changes in prices and consumer purchasing behaviour. Overall, they estimate a reduction in energy intake from soft drinks of approximately 6,600 kcal per capita per year, equivalent to about 4.5 g of sugar per day. Their estimated price-induced behavioural effect therefore corresponds to a reduction of approximately 0.9 g of sugar per day. This estimate is of a similar order of magnitude to our simulated reduction of 0.61 g per capita per day, suggesting that our model provides predictions that are broadly consistent with the estimated price effect of sugar taxation.

However, the study is subject to some limitations. Firstly, we do not account for supply-side responses to sugar taxation other than price adjustments. Firms may respond by reformulating products to reduce their sugar content and thus lower their tax liability, particularly when taxes are based on sugar-content thresholds (Andreyeva et al., 2022). As a result, our estimates may understate the potential health benefits of sugar taxation, since reformulation would reduce consumers' sugar intake even if purchasing behaviour remained unchanged. Secondly, we only considered three sectors of sugary products, ignoring potential effects of the tax on other markets. Consumers facing price increases in these categories may substitute toward untaxed sugary products in different categories. For example, Oddo et al. (2021) demonstrate how the soda tax could impact sales of untaxed sweets in Seattle. Therefore, such cross-category substitution could offset the expected reduction in sugar consumption, highlighting the potential relevance of implementing a more comprehensive tax on all sugary products. Modelling the entire diet would be challenging, given the need to consider demand and supply reactions in all relevant markets. This would require modelling the structure of all markets and considering a large number of products in the choice set. Furthermore, more complex demand models are required to account for multiple choices (Hendel, 1999; Bhat, 2005; Gentzkow, 2007; Bhat, 2018). Finally, introducing taxes and public communication around this policy instrument could change consumer preferences for sugary products. In this analysis, however, we assume that preferences remain unaffected.

6 Conclusions

This paper presents a three-step approach for evaluating the nutritional and economic effects of a two-tier sugar tax on the non-alcoholic beverages, biscuits, and dairy desserts markets in France, Spain, and the UK. Our findings suggest that such a tax would reduce sugar intake across these three markets, particularly in the non-alcoholic beverages sector, but also in the French dairy desserts sector. This reduction comes at an economic cost to consumers and firms. However, the reduction in social costs due to the health benefits of reduced sugar intake can offset these costs for society as a whole.

More broadly, our findings contribute to the debate on whether sugar taxation should be extended beyond sugar-sweetened beverages. They indicate that an SDIL-type tax can reduce sugar intake in the biscuit and dairy dessert markets, though the estimated effects remain smaller than in the beverage sector across all three countries. Crucially, once the health benefits associated with lower sugar consumption are taken into account, the overall welfare balance turns positive in most markets and countries considered. This suggests that extending sugar taxes to food categories can be welfare-improving, and that policymakers should weigh the social cost of sugar, not merely the direct losses to consumers and firms, when assessing the case for broader fiscal measures. The cross-country variation in our results further underscores that the scope of such policies will depend on country-specific market structures and consumption patterns. In France, substantial welfare gains are expected from taxing dairy desserts, whereas no positive welfare effects are anticipated in the biscuit market, suggesting that extending sugar taxation to dairy desserts would be the most effective option. In both Spain and the UK, taxing either market is expected to improve welfare. However, welfare gains are larger for dairy desserts than for biscuits in the UK, while the opposite pattern is observed in Spain, where taxing biscuits appears to be the more effective policy option.

References

ALLAIS, O., F. ETILÉ, AND S. LECOCQ (2015): "Mandatory labels, taxes and market forces: An empirical evaluation of fat policies," *Journal of Health Economics*, 43, 27–44.

ANDREYEVA, T., K. MARPLE, S. MARINELLO, T. E. MOORE, AND L. M. POWELL (2022): "Outcomes following taxation of sugar-sweetened beverages: a systematic review and meta-analysis," *JAMA Network Open*, 5, e2215276–e2215276.

ANSES (2017): "Étude individuelle nationale des consommations alimentaires 3 (INCA 3)," *Rapport d'expertise collective, Édition scientifique*.

BERRY, S. (1994): "Estimating discrete-choice models of product differentiation," *RAND Journal of Economics*, 25, 242–262.

BERRY, S., J. LEVINSOHN, AND A. PAKES (1995): "Automobile Prices in Market Equilibrium," *Econometrica*, 63, 841–890.

BHAT, C. R. (2005): "A Multiple Discrete–Continuous Extreme Value Model: Formulation and Application to Discretionary Time-Use Decisions," *Transportation Research Part B: Methodological*, 39, 679–707.

——— (2018): "A New Flexible Multiple Discrete–Continuous Extreme Value (MDCEV) Choice Model," *Transportation Research Part B: Methodological*, 110, 261–279.

BIRO, A. (2015): "Did the junk food tax make the Hungarians eat healthier?" *Food Policy*, 54, 107–115.

BONNET, C. AND V. RÉQUILLART (2013): "Tax incidence with strategic firms in the soft drink market," *Journal of Public Economics*, 77–88.

BRAMBILA-MACIAS, J., B. SHANKAR, S. CAPACCI, M. MAZZOCCHI, F. J. PEREZ-CUETO, W. VERBEKE, AND W. B. TRAILL (2011): "Policy interventions to promote healthy eating: a review of what works, what does not, and what is promising," *Food and Nutrition Bulletin*, 32, 365–375.

BURKI, T. (2023): "New junk food legislation in Colombia," *The Lancet Oncology*, 24.

CAWLEY, J., D. FRISVOLD, A. HILL, AND D. JONES (2019): "The impact of the Philadelphia beverage tax on purchases and consumption by adults and children," *Journal of Health Economics*, 67, 102225.

Cobiac, L. J., N. T. Rogers, J. Adams, et al. (2024): "Impact of the UK Soft Drinks Industry Levy on health and health inequalities in children and adolescents in England: an interrupted time series analysis and population health modelling study," *PLOS Medicine*, 21, e1004371.

Department for Environment, Food and Rural Affairs (2020): "National Food Strategy: Part Two," Tech. rep.

Dickson, A., M. Gehrsitz, and J. Kemp (2025): "Does a Spoonful of Sugar Levy Help the Calories Go Down? An Analysis of the UK Soft Drinks Industry Levy," *The Review of Economics and Statistics*, 107, 1754–1763.

Dubuisson, C., A. Dufour, S. Carrillo, P. Drouillet-Pinard, S. Havard, and J.-L. Volatier (2019): "The Third French Individual and National Food Consumption (INCA3) Survey 2014–2015: method, design and participation rate in the framework of a European harmonization process," *Public Health Nutrition*, 22, 584–600.

Gentzkow, M. (2007): "Valuing New Goods in a Model with Complementarity: Online Newspapers," *American Economic Review*, 97, 713–744.

Griffith, R., M. O'Connell, and L. Nesheim (2010): "Sin taxes in differentiated product oligopoly: an application to the butter and margarine market," *CeMMAP working papers 37/10*.

Heiss, F. and V. Winschel (2008): "Likelihood approximation by numerical integration on sparse grids," *Journal of Econometrics*, 144, 62–80.

Hendel, I. (1999): "Estimating Multiple-Discrete Choice Models: An Application to Computerization Returns," *Review of Economic Studies*, 66, 423–446.

Huang, Y. e. a. (2023): "Dietary sugar consumption and health: umbrella review," *BMJ*, 381, e071609.

Imamura, F. e. a. (2015): "Consumption of sugar sweetened beverages, artificially sweetened beverages, and fruit juice and incidence of type 2 diabetes," *BMJ*, 351, h3576.

Institute for Health Metrics and Evaluation (2022): "Global Burden of Disease Study 2019 (GBD 2019) Results," Tech. rep., available at https://vizhub.healthdata.org/gbd-results and https://vizhub.healthdata.org/gbd-compare.

Janzi, S. e. a. (2024): "Added sugar intake and its associations with incidence of seven different cardiovascular diseases," *Frontiers in Public Health*, 12.

Lara Castor, L., R. Micha, F. Cudhea, V. Miller, P. Shi, J. Zhang, J. Sharib, J. Erndt-Marino, S. Cash, S. Barquera, D. Mozaffarian, and A. Memon (2024): "Intake of sugar sweetened beverages among children and adolescents in 185 countries between 1990 and 2018: population based study," *British Medical Journal*, 386.

Lee, M. M., J. Falbe, D. Schillinger, S. Basu, C. E. McCulloch, and K. A. Madsen (2019): "Sugar-sweetened beverage consumption 3 years after the Berkeley, California, sugar-sweetened beverage tax," *American Journal of Public Health*, 109, 637–639.

Li, H., H. Liang, H. Yang, X. Zhang, X. Ding, R. Zhang, Y. Mao, Z. Liu, Q. Kan, and T. Sun (2022): "Association between intake of sweetened beverages with all-cause and cause-specific mortality: a systematic review and meta-analysis," *Journal of Public Health*, 44, 516–526.

Malik, V. S., B. M. Popkin, G. A. Bray, J.-P. Després, and F. B. Hu (2010): "Sugar-sweetened beverages and risk of metabolic syndrome and type 2 diabetes: a meta-analysis," *Diabetes Care*, 33, 2477–2483.

McFadden, D. and K. Train (2000): "Mixed MNL models for discrete response," *Journal of Applied Econometrics*, 15, 447–470.

Nevo, A. (2001): "Measuring market power in the ready-to-eat cereal industry," *Econometrica*, 69, 307–342.

Oddo, V. M., J. Leider, and L. M. Powell (2021): "The Impact of Seattle's Sugar-Sweetened Beverage Tax on Substitution to Sweets and Salty Snacks," *The Journal of Nutrition*, 151, 3232–3239.

Open Food Facts (2012): "Food products database," Tech. rep.

Pell, D., O. Mytton, T. L. Penney, A. Briggs, S. Cummins, C. Penn-Jones, M. Rayner, H. Rutter, P. Scarborough, S. J. Sharp, et al. (2021): "Changes in soft drinks purchased by British households associated with the UK soft drinks industry levy: controlled interrupted time series analysis," *British Medical Journal*, 372.

Pell, D., T. L. Penney, O. Mytton, A. Briggs, S. Cummins, M. Rayner, H. Rutter, P. Scarborough, S. J. Sharp, R. D. Smith, et al. (2020): "Anticipatory changes in British household purchases of soft drinks associated with the announcement of the Soft Drinks Industry Levy: A controlled interrupted time series analysis," *PLoS medicine*, 17, e1003269.

PETRIN, A. AND K. TRAIN (2010): "A Control Function Approach to Endogeneity in Consumer Choice Models," *Journal of Marketing Research*, 47, 3–13.

PUBLIC HEALTH ENGLAND (2016): "The childhood obesity plan," Tech. rep.

——— (2018): "Results of the National Diet and Nutrition Survey (NDNS) rolling programme for 2014 to 2015 and 2015 to 2016," Tech. rep.

——— (2020): "Sugar reduction: report on progress between 2015 and 2019," Tech. rep.

REVELT, D. AND K. TRAIN (1998): "Mixed Logit with Repeated Choices: Households' Choices of Appliance Efficiency Level," *Review of Economics and Statistics*, 80, 647–657.

ROBERTO, C. A., H. G. LAWMAN, M. T. LEVASSEUR, N. MITRA, A. PETERHANS, B. HERRING, AND S. N. BLEICH (2019): "Association of a beverage tax on sugar-sweetened and artificially sweetened beverages with changes in beverage prices and sales at chain retailers in a large urban setting," *Journal of the American Medical Association*, 321, 1799–1810.

ROYO-BORDONADA, M. Á., C. FERNÁNDEZ-ESCOBAR, L. SIMÓN, B. SANZ-BARBERO, AND J. PADILLA (2019): "Impact of an excise tax on the consumption of sugar-sweetened beverages in young people living in poorer neighbourhoods of Catalonia, Spain: a difference in differences study," *BMC Public Health*, 19, 1–11.

RUIZ, E., P. RODRIGUEZ, T. VALERO, J. M. ÁVILA, J. ARANCETA-BARTRINA, Á. GIL, M. GONZÁLEZ-GROSS, R. M. ORTEGA, L. SERRA-MAJEM, AND G. VARELA-MOREIRAS (2017): "Dietary Intake of Individual (Free and Intrinsic) Sugars and Food Sources in the Spanish Population: Findings from the ANIBES Study," *Nutrients*, 9, 275.

SEIDEL, F., B. OEBEL, L. STEIN, A. MICHALKE, AND T. GAUGLER (2023): "The True Price of External Health Effects from Food Consumption," *Nutrients*, 15, 3386.

TE MORENGA, L., S. MALLARD, AND J. MANN (2013): "Dietary sugars and body weight: systematic review and meta-analyses of randomised controlled trials and cohort studies," *British Medical Journal*, 346.

THE LANCET GASTROENTEROLOGY & HEPATOLOGY (2020): "Voluntary agreements with industry: no sweet success," *The Lancet Gastroenterology & Hepatology*, 5.

von Philipsborn, P., O. Huizinga, A. Leibinger, D. Rubin, J. Burns, K. Emmert-Fees, S. Pedron, M. Laxy, and E. Rehfuess (2023): "Interim Evaluation of Germany's Sugar Reduction Strategy for Soft Drinks: Commitments versus Actual Trends in Sugar Content and Sugar Sales from Soft Drinks," *Annals of Nutrition and Metabolism*, 79.

Wang, M., M. Yu, L. Fang, and R. Hu (2015): "Association between sugar-sweetened beverages and type 2 diabetes: A meta-analysis," *Journal of Diabetes Investigation*, 6, 360–366.

World Cancer Research Fund International (2022): "NOURISHING and MOVING Policy Databases," Tech. rep.

World Health Organization (2015): "Guideline: Sugars intake for adults and children," Tech. rep.

——— (2016): "Fiscal policies for diet and the prevention of noncommunicable diseases," Tech. rep.

——— (2022): "Fiscal policies to promote healthy diets: policy brief," Tech. rep.

A Data

A.1 Market definition

The preliminary data cleaning excludes the products that do not enter the market definition and products considered as price outliers.[1] Purchases from households with sample weight equal to 0 are also excluded, that is we consider purchases of households who are fully active in the period.

Table A.1: Summary of the market definition

Non-alcoholic beverages	**France**	**UK**	**Spain**
Sugar-sweetened beverages (cola, iced tea, lemonade, fruit-flavoured drink, sport and energy drink, tonic, other)	yes	yes	yes
Fruit juice (pure fruit juice, nectar, smoothie, fruit juice with milk)	yes	yes	yes
Flavoured water	yes	yes	yes
Milk-based drinks	no	yes	no
Water	no	no	no
Syrup, powdered drink, cocktail mixer	no	no	no
Biscuits	**France**	**UK**	**Spain**
Biscuits	yes	yes	yes
Biscuits coated with chocolate	yes	yes	yes
Chocolate bar $<$ 2 fingers	no	yes	no
Chocolate bar $>$ 2 fingers	no	no	no
Chocolate tablet	no	no	no
Sweets	no	no	no
Desserts	**France**	**UK**	**Spain**
Yogurts	yes	yes	yes
Other Dairy Desserts	yes	yes	yes
Fresh Cheese and Petits Suisses	yes	yes	no

Notes: This table presents the products included in each market for the three countries.

[1]We also exclude products with price outliers because they might be errors or they are not a direct substitute for standard non-alcoholic beverages or biscuits. Products with a price higher than 10 euros per litre in the non-alcoholic beverages market and 50 euros per kg in the biscuits markets are considered as price outliers.

A.2 Demographic characteristics

Table A.2: Household characteristics in Kantar panel

	France		UK		Spain	
	N	%	N	%	N	%
Household composition						
Without children	12,055	61	16,093	65	4,624	59
With children below 6 years old	1,881	10	2,960	12	1,092	14
With children 7-16 years old	3,838	19	3,668	15	1,586	20
With children both below 6 and 7-16 years old	1,905	10	1,865	8	585	7
Obesity status						
No overweight or obese adults	7,317	37	5,972	24	2,083	27
Some overweight or obese adults	6,674	34	8,184	33	3,423	43
All overweight or obese adults	5,688	29	10,430	43	2,381	30
Socio-economic class						
Rich	2,719	14	5,262	21	1,529	19
Average	14,136	72	13,912	57	4,772	61
Poor	2,824	14	5,412	22	1,586	20
All	**19,679**		**24,586**		**7,887**	

Notes: This table presents the distribution of households for each national consumer panel, overall and by household composition, obesity status, and socioeconomic class.

A.3 Product definition

Sub-categories

Non-alcoholic beverages market: We create 14 different sub-categories of non-alcoholic beverages, reported in Table A.3. The sugar-sweetened beverage category is made up of colas, iced tea, fruit-flavoured drinks, flavoured water, tonic water, lemonade, energy drinks, and other SSBs. The fruit juice category includes nectar, fruit juice made from concentrate, pure fruit juices, fruit juice with milk, and smoothies. Milk-based drinks are made up of flavoured milk. The sub-categories may be different between countries because Kantar does not use the same drinks classification between countries (e.g., flavoured milk is considered as a SSBs by Kantar in the UK market) and because consumption levels are different and so grouped in the "Other SSBs", "pure fruit juice" or "nectar" sub-category to avoid having too much noise in the estimation process.

Table A.3: Non-alcoholic beverages sub-categories

	France	UK	Spain
Sugar sweetened beverages (SSB)			
Colas	✓	✓	✓
Iced teas	✓	with Other SSBs	✓
Fruit-flavoured drinks	✓	✓	✓
Flavoured waters	✓	✓	with Other SSBs
Tonic waters	with Other SSBs	✓	with Other SSBs
Lemonades	with Other SSBs	✓	✓
Energy drinks	with Other SSBs	✓	✓
Other SSBs	✓	✓	✓
Fruit juice			
Nectars	✓	✓	✓
Fruit juice (from concentrate)	✓	with Pure fruit juice	with Pure fruit juice
Pure fruit juice	✓	✓	✓
Fruit juice with milk			✓
Smoothies	with Nectar	✓	
Milk-based drinks			
Flavoured milks		✓	

Notes: This table describes the sub-categories in the non-alcoholic beverage market. A sub-category specified as "with *X*" means that the purchases of this category are grouped with those of *X* category.

Biscuits market: The data contain information on the type of biscuits (e.g., Jaffa Cakes, Mallows, Rich Tea, Shortbread, Wafer). In contrast to the non-alcoholic beverages market, the supply of biscuit is country-specific. We cannot construct homogeneous sub-categories of biscuits. These sub-categories are presented in Table A.4.

Table A.4: Biscuit sub-categories

France	*Assortiment, Barquette, Barre Biscuite, Boudoir,Cookies, Croquant, Feuillete, Genoise, Petit Beurre, Sable, Speculos*
UK	*Assortment, Breakfast, Cereal Bars, Coated, Cookies, Digestives, Dips, Fig Rolls, Fingers, Fruit Bars, Half Iced, Jaffa Cakes, Jam, Mallows, Rich Tea, Shortbread, Wafer*
Spain	*Barquillo, Especialidades, Galleta Banada, Galleta Bizcocho, Galleta Mantequila, Galleta Maria, Galleta Relieve,Galeta Relena, Galleta tostada, Pasta de Te, Surtido Galleta*

Notes: This table describes the sub-categories in the biscuit market. A sub-category is created for each country, named "Biscuit", which represents an aggregate of products that did not enter the previous subcategory.

Fresh desserts market: As for biscuits, the supply of fresh desserts is country-specific. Despite some similarities, we cannot construct homogeneous sub-categories of fresh desserts. These sub-categories are presented in Table A.5.

Table A.5: Fresh desserts sub-categories

France	*Plain yogurts without added sugar, Plain yogurts with added sugar, Flavored yogurts, Yogurts with fruits, Diverse (ODD), Creams, Liégeois, Mousses, Egg creams, Rice/semolina puddings, Plain FCPS without added sugar, Flavored FCPS*
UK	*Plain yogurts without added sugar, Plain yogurts with added sugar, Yogurts with fruits, Yogurts with assortment, Yogurts diverse, Liquid yogurts and juices without added sugar, Liquid yogurts and juices with added sugar, Tiramisus, Cheesecakes, Rice puddings, Trifle, Diverse (ODD), Plain FCPS without added sugar, FCPS with fruits, FCPS diverse*
Spain	*Plain yogurts without added sugar, Plain yogurts with added sugar, Flavored yogurts, Yogurts with cereals, Yogurts with accompaniments, Yogurts with fruits, Creams, Flans, Jellies, Natillas, Diverse (ODD)*

Notes: This table describes the sub-categories in the dairy dessert market.

Added sugar content

In the non-alcoholic beverages market, natural sugars come only from fruit. This means that pure fruit juices and fruit juices from concentrate do not contain added sugar. We assume that all other drinks with a positive sugar content contain added sugar. We consider all biscuit products to contain added sugar in the three countries. Natural sugar comes from milk in the dairy desserts market. Plain yogurt and FBPS contain natural sugars, but no added sugars. The amount of sugar in plain dairy desserts can vary from 3 to 7 g per 100 g. We consider added sugar to be present when the sugar content exceeds 7 g per 100 g of product.

Definition of the differentiated products

Non-alcoholic beverages markets: The definition of the differentiated products is based on information on the firm name (e.g., Coca-Cola), the brand name (e.g., Coca-Cola, Fanta, Sprite, ...), the drinks subcategory, and other product characteristics (diet or regular for SSBs, and the presence of added sugar and flavour for fruit juice).[2,3] Beverages in a given subcategory with low purchase frequency are aggregated with similar products from the same firm or with a hypothetical product defined as "other firm/other brand" in the same subcategory. Following this product differentiation, we obtain 319, 402 and 285 distinct beverage varieties (hereafter referred to as "alternatives"), which we consider in our analysis of the non-alcoholic beverage market in France, the UK and Spain, respectively. These alternatives fall into five nutritional categories: diet SSB, regular SSB and fruit juices, which are divided into three sugar content levels: low, medium and high. Table A.6 presents a summary of the market structure and the definition of alternatives in the non-alcoholic beverages market. We also report the number of purchases and the average price per litre of non-alcoholic

[2]Private labels are aggregated into one firm and one brand.
[3]A Flavoured water is considered as diet if it contains 1 gram or less of sugar per 100 ml.

beverages and non-alcoholic beverages with added sugar in each market. The number of firms and national brands is similar in France and Spain (60 in France, 78 in the UK and 50 in Spain, Table A.6). The UK market is characterised by a higher number of national brands (151 vs. 119 in France and 109 in Spain), resulting in a greater variety of alternatives in the non-alcoholic beverage market.

Biscuits market: We identify 57 firms competing in the French biscuits market, 70 in the UK and 71 in Spain. The market is characterized by a substantial heterogeneity in the size of firms. In contrast, there is much more national brands in the UK than in Spain (104 vs. 84 and 87 in France and Spain, respectively, Table A.6). A key characteristic of the market is that huge multinational companies, such as Mondelez and Nestlé, co-exist with a large number of small firms. To reduce the number of product alternatives, we aggregate small firms into a group called "Other firms" and gather all private labels sold by retailers into one group. Following our process, we also consider sub-brand information. For example, to distinguish between LU Granola and LU Prince, which are both from the LU brand, we consider sub-brands, in this case "Granola" or "Prince". We then use country-specific subcategories of biscuits to define our alternatives. Finally, we use information on the flavour of the biscuits (e.g., chocolate or vanilla) to describe these products more precisely. Crossing these characteristics yields 407 alternatives in France, 500 in the UK and 309 in Spain, with at least 50 purchases of each product.

Desserts market: The definition of the differentiated products is based on information on the firm name, the brand name, the drinks sub-category, and other product characteristics such as plant-based ingredient instead of dairy milk, fatness class, and presence of sweeteners.[4,5] Desserts in a given sub-category with low purchase frequency are aggregated with similar products from the same firm or with a hypothetical product defined as "other firm/other brand" in the same sub-category. This yields 266 alternatives in France, 171 in the UK, and 281 in Spain. The number of firms is similar in France and Spain (14), but substantially higher in the UK (25). The number of retailers among the considered firms is similar in France (8), the UK (10), and Spain (9).

Prices

The price of each alternative is calculated as the weighted ratio of total expenditure in euros over the total quantities in litres or kilogram of all items belonging to the alternative in a four-week period.[6]

[4] Private labels are aggregated in one firm and one brand.

[5] The plant-based characteristics are available for each country, but the fatness classes are only present in Spain and France, and the presence of sweeteners only in Spain. The fatness classes are defined by the type of skimming for yogurts (which may not be fully correlated with the actual fat content) and the fat category that must be legally displayed on FCPS.

[6] The following conversion rate is used: 1 pound = 1.15 euros for the UK market

The weights used are Kantar period-specific household sample weights.[7]

Table A.6: Market structure

Non-alcoholic beverages	**France**	**UK**	**Spain**
Number of firms	60	78	50
Number of national brands	119	151	109
Number of sub-categories	8	11	10
Number of alternatives	319	402	285
Number of observations	666,482	1,319,069	270,211
Mean price (per litre)	1.18 €	0.78 €	0.84 €
Mean price of non-alcoholic beverages with added sugar (per litre)	1.02 €	0.67 €	0.82 €
Biscuits	**France**	**UK**	**Spain**
Number of firms	57	70	71
Number of national brands	84	104	87
Number of sub-categories	12	18	12
Number of alternatives	407	500	309
Number of observations	482,154	860,461	141,177
Mean price (per kg)	6.10 €	4.24 €	3.34 €
Desserts	**France**	**UK**	**Spain**
Number of firms	7	14	6
Number of national brands	32	44	36
Number of sub-categories	13	15	11
Number of alternatives	266	171	281
Number of observations	1,213,460	1,056,660	346,860
Mean price (per kg)	2.47€	3.01€	2.18€

Notes: This table presents a summary of the market structure for the three countries with the number of firms, national brands, sub-categories, alternatives, observations and the average price. The number of observations refers to the number of Kantar references purchased per household, date and store. Mean price is computed as the ratio of the weighted sum of expenses to the weighted sum of quantities.

The average prices in Table A.6 are calculated as the ratio of the total expenditure in euros to the total quantity in litres of all drinks or in kilograms of all biscuits or dairy desserts purchased in each market. On average, non-alcoholic beverages are more expensive in France than in the UK and Spain (1.18 € per litre, vs. 0.67 and 0.84 € in the UK and Spain, respectively). Non-alcoholic beverages with added sugar are on average less expensive than the other categories of non-alcoholic beverages in the all three countries. Biscuits are much more expensive than non-alcoholic beverages. They are more expensive in France than in the other two countries (6.10 € per kg of biscuit vs. 4.24 and 3.34 € in the UK and Spain, respectively). Desserts are more expensive than non-alcoholic beverages but cheaper than biscuits. They are cheapest in Spain (2.12€ /kg) followed by France (2.46€ /kg) and

[7]These weights are calculated by Kantar. They ensure that the panel is representative and correct for reporting biases related to periods away from home.

the UK (3.01€ /kg).

A.4 Additional tables

Table A.7: Initial sugar purchases (g/day/capita)

	Non-alcoholic beverages			Biscuits			Desserts		
	France	UK	Spain	France	UK	Spain	France	UK	Spain
All	9.84	6.36	6.16	4.32	4.30	2.65	7.82	3.61	5.06
Household composition									
Without children	9.52	6.28	6.19	4.02	4.54	2.46	8.23	4.46	5.06
With children <6	8.79	4.70	5.19	3.83	2.78	2.18	6.75	2.76	4.35
With children 7-16	11.52	8.19	6.70	5.23	4.62	3.40	7.32	3.31	5.36
With children <6 & 7-16	9.51	6.09	6.28	4.88	4.00	2.99	7.22	3.24	5.62
Obesity status									
No overweight or obese	9.22	6.08	5.02	4.26	3.87	2.50	7.30	3.36	4.83
At least one overweight or obese	10.12	6.47	6.52	4.29	4.18	2.69	7.66	3.49	4.86
All overweight or obese	10.29	6.44	6.63	4.43	4.64	2.74	8.66	3.85	5.55
Socio-economic class									
Rich	8.64	5.90	5.69	3.60	3.73	2.59	7.89	3.52	4.87
Middle	9.85	6.33	6.08	4.35	4.31	2.73	7.98	3.70	5.10
Poor	10.91	6.88	6.83	4.85	4.85	2.50	6.95	3.47	5.14

Notes: This table displays the (non-weighted) average sugar purchases observed in the panel, computed across households. It is expressed in grams per day per capita.

B Empirical modelling: demand and supply models

In line with the empirical industrial organisation literature, the market is modelled by combining a flexible discrete-choice model of demand for differentiated products with a supply model that assumes oligopolistic competition. The estimation method involves two steps. First, we estimate a demand model independently in order to understand household preferences for each of the three markets in each country. Secondly, we use the estimated consumer substitution patterns to model the supply side (i.e., the nature of competition between firms) in order to determine the pricing strategies and marginal costs of each product.

B.1 The demand model

We use a flexible discrete-choice model to estimate demand and obtain own- and cross-price elasticities for each alternative. We opt for this type of demand model because accurately evaluating the impact of policies on specific markets is imperative. Specifically, we use a random coefficient logit model (RCLM) (Berry et al., 1995; McFadden and Train, 2000). This model specifies preferences over product characteristics in a flexible manner, allowing for both observed and unobserved heterogeneity in consumer preferences.

B.1.1 The random coefficient logit model

Following Revelt and Train (1998), let t denote the index of time ($t = 1,\ldots,T$), i the index of the household in the sample ($i = 1,\ldots,N$) and j the index of the product inside the choice set of differentiated products ($j = 1,\ldots,J_t$) at time t.

Utility. The indirect utility function V_{ijt} for household i buying product j in period t is given by

$$V_{ijt} = \alpha_i p_{jt} + \beta_i X_{jt} + \epsilon_{ijt} \tag{1}$$

where p_{jt} is the price of product j in period t, α_i is the marginal disutility of the price for household i, X_{jt} is a vector of observed product characteristics, β_i is the vector of associated parameters that capture the individual taste for product characteristics, and ϵ_{ijt} is an individual error term.

We assume that parameter α_i varies across households, with some unobserved heterogeneity. Indeed, households can have a different price disutility. It can be rewritten as

$$\alpha_i = \alpha + \pi^{\alpha} D_i + \sigma \nu_i \tag{2}$$

where α is the mean marginal disutility of the price for all households, π the vector of parameters associated with demographic characteristics D_i (family composition, obesity status and socio-economic class of the household), and ν_i measures the unobserved heterogeneity of the households. We denote $P_{\nu}(.)$ the distribution of parameter ν. For all markets and all countries, we specify the price disutility as follows: $\alpha_i = \alpha + \alpha_{\text{child(i)}} + \alpha_{\text{obesity(i)}} + \alpha_{\text{class(i)}} + \sigma \nu_i$.
The vector product characteristics vary per market and country. A summary of variable choices is presented in column 1 of Table B.1. Additionally, the parameter β_i also depends on household characteristics. It can be rewritten as $\beta_i = \beta + \pi^{\beta} H_i$ where β represents the vector of the average individual's taste for product characteristics and π^{β} is the vector of coefficients associated with household demaographics D_i. Table B.1 in column 2 summarises the interactions considered for each market and country.

We can divide the indirect utility between a mean utility $\delta_{jt} = \alpha p_{jt} + \beta X_{jt} + \xi_{jt}$ where ξ_{jt} captures all unobserved product characteristics and a deviation from this mean utility $\mu_{ijt} = (\sigma \nu_i + \pi^{\alpha} D_i) p_{jt} + \pi^{\beta} H_i X_{jt}$. Hence the indirect utility is given by

$$V_{ijt} = \delta_{jt} + \mu_{ijt} + \epsilon_{ijt} \tag{3}$$

A household is defined by the vector $(\nu_i, D_i, \varepsilon_{i0t}, ..., \varepsilon_{iJt})$.

Outside option. The household can decide not to buy one of the considered products. It is represented by the non-purchase behavior at period t.The utility of this option is normalised to zero. The indirect utility of choosing the outside option is written as $V_{i0t} = \epsilon_{i0t}$.

Market share. We assume that ϵ_{ijt} is independently and identically distributed as an extreme value type I distribution. The conditional probability that household i chooses product j in period t is:

$$s_{ijt}(\nu) = \frac{exp(\delta_{jt} + \mu_{ijt})}{1 + \sum_{k=1}^{J_t} exp(\delta_{kt} + \mu_{ikt})} \tag{4}$$

The market share of product j in period t is (Nevo, 2001):

$$s_{jt} = \int_{A_{jt}} \left(\frac{\exp(\delta_{jt} + \mu_{ijt})}{1 + \sum_{k=1}^{J_t} \exp(\delta_{kt} + \mu_{ikt})} \right) dP_{\nu}(\nu) \tag{5}$$

where A_{jt} is the set of households who have the highest utility for product j in period t and P_ν is the cumulative distribution function of ν which is typically assumed to be standard normal.

Elasticity. The random coefficient logit model generates a flexible pattern of substitutions between products. We can then write the own-price and cross-price elasticities of the market share s_{jt} as:

$$\theta_{jkt} = \frac{\partial s_{jt}}{\partial p_{kt}} \frac{p_{kt}}{s_{jt}} = \begin{cases} \frac{p_{jt}}{s_{jt}} \int \alpha_i s_{ijt}(1-s_{ijt})\phi(\nu_i)\mathrm{d}\nu_i & \text{if } j=k \\ -\frac{p_{kt}}{s_{jt}} \int \alpha_i s_{ijt} s_{ikt} \phi(\nu_i)\mathrm{d}\nu_i & \text{otherwise} \end{cases} \tag{6}$$

where $\phi()$ is the density function of $P_\nu(.)$.

Table B.1: Summary demand specification

Market/Country	Product characteristics X_j	Demographic interaction with X_j
Non-alcoholic beverages markets		
France	Pure juice, diet, sugar content for SSBs, sugar content for fruit juices, brand fixed effects	Diet is interacted with children < 6 and children 7-16 , sugar content (SSBs and fruit juices) is interacted with children < 6 and children 7-16
UK	Diet, sugar content for SSBs, sugar content for fruit juices, subcategory and brand fixed effects	Diet is interacted with children < 6 and children 7-16, sugar content (SSBs and fruit juices) is interacted with children < 6 and children 7-16
Spain	Pure juice, fruit drink, fruit juice with milk diet, sugar content for SSBs, sugar content for fruit juices, subcategory and brand fixed effects	Diet is interacted with children < 6 and children 7-16 , sugar content SSBs and fruit juices) is interacted with children < 6 and children 7-16
Biscuits markets		
France	Sugar content, lipid content, an interaction term between both, brand fixed effects	Sugar is interacted with children < 6 and children 7-16 , sugar x lipid is interacted with children < 6 and children 7-16
UK	Sugar content, lipid content, an interaction term between both, brand fixed effects	Sugar is interacted with children < 6 and children 7-16 , sugar x lipid is interacted with children < 6 and children 7-16
Spain	Sugar content, lipid content, an interaction term between both, brand fixed effects	Sugar is interacted with children < 6 and children 7-16 , sugar x lipid is interacted with children < 6 and children 7-16
Desserts markets		
France	Sugar content, saturated fat, planted-based, subcategory and brand fixed effects	Sugar is interacted with children < 6 and children 7-16
UK	Sugar content, fat, planted-based, subcategory and brand fixed effects	Sugar is interacted with children < 6 and children 7-16
Spain	Sugar content, saturated fat, sweeteners, subcategory and brand fixed effects	Sugar is interacted with children < 6 and children 7-16

Notes: This table summarizes the specifications of the nine demand estimations.

B.1.2 Identification

This method relies on the assumption that all product characteristics X_{jt} are independent of the error term ϵ_{ijt}, which can be decomposed into a product-specific error term and an individual error term, $\epsilon_{ijt} = \xi_{jt} + e_{ijt}$. However, there is empirical evidence that unobserved factors included in ξ_{jt} can be correlated with observed characteristics X_{jt}, producing endogeneity problems (Berry, 1994). Such unobserved characteristics can be promotions or advertising, for example. For instance, promoted products are often moved to the front of the shelf, advertised, and sold at a lower price at the same time. Since we do not have any information on advertising expenditure spent by firms, the estimated impact of observed prices on demand will then capture both a true price effect and the effect of unobserved marketing efforts. Prices may also be endogenous if some unobserved characteristics are positively valued by consumers, who are thus ready to pay a premium for them. This may be taken into account by firms in setting their prices.

To solve the problem that omitted product characteristics might be correlated with prices, we use a control function approach as in Petrin and Train (2010). We then regress prices on instrumental variables (W_{jt}) and observed characteristics X_j of the demand equation:

$$p_{jt} = W_{jt}\gamma + X_j\mu + \eta_{jt} \tag{7}$$

where η_{jt} is an error term that captures the remaining unobserved variations in prices. The estimated error term $\widehat{\eta}_{jt}$ of the price equation includes some omitted variables such as advertising variations and promotions or omitted product characteristics that could explain price variations across products and time periods. Introducing this term in the mean utility of consumers δ_{jt} allows us to capture unobserved product characteristics varying across time. Prices are now uncorrelated with the new product-specific error term varying across periods ($\zeta_{jt} = \xi_{jt} - \lambda\widehat{\eta}_{jt}$). We then write

$$\delta_{jt} = \alpha p_{jt} + \beta X_{jt} + \lambda\hat{\eta}_{jt} + \zeta_{jt} \tag{8}$$

where λ is the estimated parameter associated with the estimated error term of the first stage.

To instrument prices, we use cost shifters, which represent a proxy for production costs, and BLP instruments, which represent the competitive environment of products, as described in (Berry et al., 1995). The cost shifters come from the following sources: INSEE price production indices for France, ONS price production indices for the United Kingdom, and INE price production indices for Spain.[8,9,10]

As they only represent a very small share of the demand for those inputs, they are not likely to be correlated with unobserved determinants of demand in each market. This justifies the absence of correlation between input prices and unobserved determinants of demand. BLP instruments are the sum of the product characteristics of competing products offered on the market in the same

[8] France: https://www.insee.fr/fr/plan-du-site/famille-bdm/102776019
[9] UK: https://www.ons.gov.uk/economy/inflationandpriceindices
[10] Spain: https://www.ine.es/jaxiT3/Tabla.htm?t=8381

segment or offered by competitive firms. In our analysis, we use either the number or the sum of the sugar content of competing products. The list of instruments used in our first-stage regression and the estimation are provided in Tables B.2, B.3 and B.4 for each market. The F-test for the nine estimations is greater than 10, indicating that the instrumental variables used are not weak.

Table B.2: Results on price equation - Non-alcoholic beverages market

	France	**UK**	**Spain**
	Coefficient (se)	Coefficient (se)	Coefficient (se)
Instrumental variables			
BLP instruments			
Number of competing products			
offered by other firms within			
- the nutritional category	-0.02*** (0.00)		
- the product category		-0.01*** (0.00)	
- the product and nutritional category			-0.02*** (0.01)
Total sugar content of competing products			
- products offered by other firms			
within the nutritional category	0.00*** (0.00)		
- within the nutritional category		-0.00*** (0.00)	
- within the product and nutritional category			0.00*** (0.00)
Cost shifter (input prices)			
Aluminium	-0.00*** (0.00)		-0.00*** (0.00)
Glass	0.00*** (0.00)	-0.00*** (0.00)	-0.00*** (0.00)
Exogenous variables			
Pure fruit juice	-0.01 (0.04)		0.65*** (0.05)
Fruit-flavoured drink			-0.05 (0.06)
Fruit juice with milk			0.10 (0.07)
Diet	0.38*** (0.06)	0.11*** (0.04)	0.10* (0.06)
Sugar (Soft drinks)	0.05*** (0.01)	0.07*** (0.01)	0.02*** (0.01)
Sugar (Fruit juices)	0.03*** (0.01)	0.28*** (0.01)	0.01 (0.01)
Brand fixed effects	yes	yes	yes
Category fixed effects	no	yes	no
IV joint significance test	F(4,3950) = 21.41	F(3,5035) = 35.97	F(4,3438) = 19.11
	Prob > F = 0.0000	Prob > F = 0.0000	Prob > F = 0.0000
Observations	4,077	5,182	3,539
R^2	0.950	0.944	0.875

Notes: This table reports the estimates from the price regression (Equation 7) for the non-alcoholic beverage market. Price is regressed on a set of instruments and all exogenous variables. Estimators' standard errors (se) are in parenthesis.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.3: Results on price equation - Biscuits market

	France	**UK**	**Spain**
	Coefficient (se)	Coefficient (se)	Coefficient (se)
Instrumental variables			
BLP instruments			
Number of competing products offered by other firms			
- within the category	-0.00*** (0.00)		
- within the category and the flavor			-0.02*** (0.00)
Total sugar content of competing products			
offered by other firms within the category		-0.00*** (0.00)	-0.06*** (0.01)
Total lipid content of competing products			
offered by other firms within the flavor		-0.01*** (0.00)	0.00*** (0.00)
Cost shifter (input prices)			
Chocolat	0.00*** (0.00)		
Exogenous variables			
Lipid	0.17*** (0.0)	0.03 (0.01)	0.10* (0.06)
Sugar	0.09*** (0.02)	0.04*** (0.01)	0.02*** (0.01)
SugarLipid	-32.00*** (5.22)	0.07 (0.01)	0.02*** (0.01)
Brand fixed effects	yes	yes	yes
IV joint significance test	F(2,5018) = 15.84	F(2,5989) = 18.72	F(3,3743) = 59.90
	Prob > F = 0.0000	Prob > F = 0.0000	Prob > F = 0.0000
Observations	5,107	6,097	3,869
R^2	0.909	0.921	0.898

Notes: This table reports the estimates from the price regression (Equation 7) for the biscuit market. Price is regressed on a set of instruments and all exogenous variables. Estimators' standard errors (se) are in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.4: Results on price equation - Dairy desserts market

	France	UK	Spain
	Coefficient (se)	Coefficient (se)	Coefficient (se)
Instrumental variables			
BLP instruments			
Number of competing products offered			
- within the same fatness class	-0.02*** (0.00)		
- by other firms with the same category		-0.01*** (0.00)	
- by the same firm within the same category			0.03*** (0.01)
Sugar quantity of competing products offered			
- by the same firm in the same fatness class	0.00*** (0.00)		
- by the same firm with the same plant-based		-0.00*** (0.00)	
- with the same plant-based characteristics			0.00*** (0.00)
Exogenous variables			
Fats	0.13*** (0.01)		
Saturated fats		0.53*** (0.02)	0.27*** (0.01)
Sugar	0.04*** (0.01)	-0.04*** (0.01)	0.03*** (0.01)
Plant-based ingredients	0.51*** (0.11)		
Sweeteners			0.40*** (0.07)
Subcategory fixed effects	yes	no	yes
Brand fixed effects	yes	yes	yes
IV joint significance test	F(2,3162) = 15.77	F(2,2,016) = 17.32	F(2,3,075) = 41.31
	Prob > F = 0.0000	Prob > F = 0.0000	Prob > F = 0.0000
Observations	3,162	2,016	3,075
R^2	0.93	0.93	0.94

Notes: This table reports the estimates from the price regression (Equation 7) for the dairy dessert market. Price is regressed on a set of instruments and all exogenous variables. Estimators' standard errors (se) are in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

B.1.3 Estimation procedure

We estimated the demand model using individual data. We used the simulated maximum likelihood method as in Revelt and Train (1998). In our model, as purchases are independent considering household and period, the likelihood function for household i can be written as:

$$L_i = \int \prod_{t=1}^{T} \prod_{j=0}^{J_t} [\frac{exp(\delta_{jt} + \mu_{ijt})}{1 + \sum_{k=1}^{J_t} exp(\delta_{kt} + \mu_{ikt})}]^{Y_{ijt}} \mathrm{d}P_{\nu}(\nu) \tag{9}$$

where Y_{ijt} is a dummy variable equal to 1 if household i chooses product j in period t and 0 otherwise.

We estimate the vector of demand parameters by maximizing the simulated log-likelihood function given by:

$$SLL = \sum_{i=1}^{N} W_i \times ln[\hat{s}_{ijt}] \tag{10}$$

where N is the total number of purchases registered by Kantar for a given market, and $W_i = N_i \times W_i^{ht}$ is the weight associated with purchase i. N_i is the number of units bought at purchase i, used to account for multiple purchases of the same product (i.e., buying three bottles of the same product at once). W_i^{ht} is the Kantar period-specific household sample weight for period t, associated with the household h that made the i^{th} purchase. $\hat{s}_{ijt}$ stands for the individual simulated market share of product j in market t:

$$\hat{s}_{ijt} = \frac{1}{R}\sum_{r=1}^{R} w_r \prod_{j=0}^{J_t}[\frac{exp(\alpha_i^r p_{jt} + \beta_i X_{jt} + \lambda \hat{\eta}_{jt})}{\sum_{k=1}^{J_t} 1 + exp(\alpha_i^r p_{kt} + \beta_i X_{kt} + \lambda \hat{\eta}_{kt})}]^{Y_{ijt}} \tag{11}$$

where R is the number of draws, w_r is the r^{th} entry in the vector of weights and $\alpha_i^r = \alpha + \pi DM_i + \sigma \nu_i^r$ with $\nu^r \sim \mathcal{N}(0,1)$.[11]

B.2 The supply side

Firms are likely to adjust to exogenous shocks, and ignoring their strategic behaviour may lead to biased estimates of the effect of public policies (Griffith et al., 2010; Bonnet and Réquillart, 2013; Allais et al., 2015). The simulation of the effects of policy shocks on the market equilibrium therefore requires a structural model of the supply side. Below, we assume that only price strategies are implemented by firms in reaction to tax. Other strategic firms' reactions, such as modifying the set of products or products reformulation, are beyond the scope of our assessment.

We consider F firms that compete in prices on the considered market and sell products to consumers and set prices. At each period, the firm maximizes its profit, conditional on the demand parameters and other firms' prices, holding the set of products offered and every other observed and unobserved characteristics constant:

$$\Pi_{ft} = \sum_{j \in G_{ft}} [M_t(p_{jt} - c_{jt}) s_{jt}(p_t)] \tag{12}$$

[11] To address the curse of dimensionality, we use a sparse grid method as it is developed in Heiss and Winschel (2008). The choice for the number of simulations is explained on http://www.sparse-grids.de/. Integration on sparse grids has low computational costs compared to other methods. The number of draws is especially reduced because each draw is associated with a weight. Let R be the number of simulations which depends on the type of integration rule, the number of dimensions and the chosen accuracy. Let x_r and w_r be the r^{th} entries respectively in the vector of draws and the vector of weights. We want ν^r to follow a standard normal distribution so we apply a transformation (inverse of the standard normal cumulative distribution function) to x_r ($x_r \in [0,1]\ \forall r$) so that $\nu^r = \Phi^{-1}(x_r)$ and $\nu^r \sim \mathcal{N}(0,1)$.

where G_{ft} is the set of products sold by firm f in period t, M_t is the size of the market in period t, p_{jt} is the price of product j in period t, c_{jt} is the constant marginal cost to produce and sell product j in period t, $s_{jt}(p_t)$ is the market share of product j in period t given the vector of product price p_t.

The equation of prices of products $j \in G_{ft}$ is determined with the first order conditions:

$$s_{jt}(p_t) + \sum_{k \in G_{ft}} [M_t(p_{kt} - c_{kt}) \frac{\partial s_{kt}}{\partial p_{jt}}] = 0 \ \forall j \in G_{ft} \tag{13}$$

We recover estimates of firms' margins $\gamma_{jt} = p_{jt} - c_{jt}$ for each product using the first-order conditions and estimates of the demand model. Using equation (13), the vector of margins $\gamma_t = (p-c)_t$ can be written in matrix notation.

$$\gamma_t = (p-c)_t = -\Big(\sum_{f=1}^{F} I_{ft} S_{pt} I_{ft}\Big)^{-1} \Big(s_t(p_t)\Big) \tag{14}$$

where I_{ft} is the ownership diagonal matrix $(J_t \times J_t)$ of firm f in period t with elements $I_{ft}(j,j)$ equal to 1 if product j is produced by firm f in period t and zero otherwise, S_{pt} is the matrix $(J_t \times J_t)$ of the first derivatives of all market shares with respect to all prices in period t, i.e., $S_{pt} = (\frac{\partial s_{kt}}{\partial p_{jt}})_{(j=1,\dots,J_t;k=1,\dots,J_t)}$ and $s_t(p_t)$ is the vector of product market shares in period t. We then derive estimates of marginal costs, given observed prices.

B.3 Demand and supply results

Table B.5: Estimates of the random coefficient logit model - Non-alcoholic beverages market

	France	**UK**	**Spain**
Price (p_{jt})			
Mean (α)	-2.65 (0.00)	-6.84 (0.00)	-5.35 (0.00)
× children below 6 years old	0.05 (0.00)	0.13 (0.00)	0.15 (0.00)
× children 7-16 years old	0.03 (0.00)	-0.03 (0.00)	-0.22 (0.00)
× middle socio-economic class	-0.36 (0.00)	-0.24 (0.00)	-0.13 (0.00)
× poor socio-economic class	-0.70 (0.00)	-0.35 (0.00)	-0.36 (0.00)
× at least one obese	-0.06 (0.00)	-0.12 (0.00)	-0.08 (0.00)
× all obese	-0.24 (0.00)	-0.15 (0.00)	0.00 (0.00)
Standard deviation (σ)	0.91 (0.00)	1.64 (0.00)	0.61 (0.00)
Pure juice	0.66 (0.00)		3.35 (0.00)
Fruit drink			0.64 (0.00)
Fruit juice with milk			1.48 (0.00)
Diet	-1.59 (0.00)	1.02 (0.00)	-0.34 (0.00)
× children below 6 years old	0.09 (0.00)	0.13 (0.00)	0.30 (0.00)
× children 7-16 years old	0.06 (0.00)	0.07 (0.00)	0.21 (0.00)
Sugar (SSBs)	-0.05 (0.00)	0.16 (0.00)	0.11 (0.00)
× children below 6 years old	0.05 (0.00)	0.03 (0.00)	0.02 (0.00)
× children 7-16 years old	0.04 (0.00)	0.02 (0.00)	0.02 (0.00)
Sugar (fruit juices)	-0.06 (0.00)	0.03 (0.00)	0.14 (0.00)
× children below 6 years old	0.04 (0.00)	0.05 (0.00)	0.08 (0.00)
× children 7-16 years old	0.04 (0.00)	0.04 (0.00)	0.07 (0.00)
Fixed effects			
Sub-category	no	yes	no
Brand (NBs & PLs)	yes	yes	yes
Error ($\hat{\eta}_{jt}$)	0.51 (0.00)	4.09 (0.00)	4.49 (0.00)
Observations	708,940	1,364,000	270,000
Log-likelihood	-1.53588e+10	-2.32081e+10	-9.05930e+09

Notes: This table reports the estimates from the demand estimation (Equation 11) for the non-alcoholic beverage market. Standard errors of coefficient estimates are in parentheses.

Table B.6: **Estimates of the random coefficient logit model - Biscuits market**

	France	**UK**	**Spain**
Price (p_{jt})			
Mean (α)	-0.42 (0.00)	-1.33 (0.00)	-0.92 (0.00)
× children below 6 years old	-0.02 (0.00)	0.02 (0.00)	0.03 (0.00)
× children 7-16 years old	-0.01 (0.00)	0.04 (0.00)	0.06 (0.00)
× middle Socio-economic class	-0.02 (0.00)	-0.01 (0.00)	-0.01 (0.00)
× poor socio-economic class	-0.05 (0.00)	-0.05 (0.00)	-0.07 (0.00)
× at least one obese	0.03 (0.00)	0.12 (0.00)	0.05 (0.00)
× all obese	-0.01 (0.00)	-0.00 (0.00)	0.02 (0.00)
Standard deviation (σ)	0.17 (0.00)	0.21 (0.00)	0.20 (0.00)
Sugar	0.02 (0.00)	0.09 (0.00)	-0.02 (0.00)
× children below 6 years old	0.02 (0.00)	0.01 (0.00)	0.02 (0.00)
× children 7-16 years old	0.02 (0.00)	0.02 (0.00)	0.03 (0.00)
Lipid	0.06 (0.00)	0.22 (0.00)	0.09 (0.00)
SugarLipid	-14.97 (0.00)	-40.38 (0.00)	-10.51 (0.00)
× children below 6 years old	1.44 (0.00)	-4.55(0.00)	-5.46 (0.00)
× children 7-16 years old	5.47 (0.00)	-1.75 (0.00)	-0.02 (0.00)
Fixed effects			
Brand (NBs & PLs)	yes	yes	yes
Error ($\hat{\eta}_{jt}$)	0.14 (0.00)	1.00 (0.00)	0.56 (0.00)
Observations	544,980	928,920	170,080
Log-likelihood	-7.63538e+09	-7.10512e+09	-2.05663e+09

Notes: This table reports the estimates from the demand estimation (Equation 11) for the biscuit market. Standard errors of coefficient estimates are in parentheses.

Table B.7: Estimates of the random coefficient logit model - Desserts market

	France	**UK**	**Spain**
Price (p_{jt})			
Mean (α)	-1.33 (0.00)	-1.22 (0.00)	-2.86 (0.00)
× children below 6 years old	-0.07 (0.00)	-0.09 (0.00)	-0.21 (0.00)
× children 7-16 years old	-0.03 (0.00)	-0.08 (0.00)	-0.30 (0.00)
× middle socio-economic class	0.01 (0.00)	-0.07 (0.00)	-0.12 (0.00)
× poor socio-economic class	0.00 (0.00)	-0.09 (0.00)	-0.20 (0.00)
× at least one obese	0.02 (0.00)	0.01 (0.00)	-0.03 (0.00)
× all obese	0.02 (0.00)	0.02 (0.00)	0.04 (0.00)
Standard deviation (σ)	0.14 (0.00)	0.16(0.00)	0.55 (0.00)
Sugar	0.09 (0.00)	0.04 (0.00)	0.14 (0.00)
× children below 6 years old	0.01 (0.00)	0.03 (0.00)	0.05 (0.00)
× children 7-16 years old	-0.00 (0.00)	0.04 (0.00)	0.07 (0.00)
Fats	0.21 (0.00)		
Saturated Fats		0.50 (0.00)	0.85 (0.00)
Plant-based ingredient	-2.20 (0.00)		
Sweeteners			1.80 (0.00)
Fixed effets			
Subcategory	yes	yes	yes
Brands	yes	yes	yes
Error ($\hat{\eta}_{jt}$)	1.17 (0.00)	1.10 (0.00)	1.61 (0.00)
Observations	1,213,460	1,056,660	346,860
Log-likelihood	-7.14e+10	-1.22e+10	-1.90e+10

Notes: This table reports the estimates from the demand estimation (Equation 11) for the dairy dessert market. Standard errors of coefficient estimates are in parentheses.

Table B.8: **Elasticities and margins by categories - Non-alcoholic beverages market**

	France		UK		Spain	
Firms	**Own-price elasticities**	**Margins (% price)**	**Own-price elasticities**	**Margins (% price)**	**Own-price elasticities**	**Margins (% price)**
Colas	-2.8	48.0	-5.7	24.3	-4.7	30.6
Iced tea	-3.4	41.9			-4.9	45.3
Fruit-flavoured drinks	-3.4	40.3	-6.3	30.5	-4.4	35.6
Flavoured waters	-2.8	47.9	-3.4	50.8	-2.9	69.7
Tonic waters	-5.1	42.6				
Lemonades			-4.1	53.2	-3.4	54.7
Energy drinks			-8.3	15.9	-7.1	23.1
Other SSBs	-3.2	51.3	-5.7	37.6	-6.2	65.8
Nectars	-3.8	40.5	-7.1	23.3	-4.9	38.7
Fruit juices	-3.7	42.0				
Pure fruit juices	-4.5	32.2	-7.8	20.8	-6.3	30.1
Smoothies	-12.5	10.4				
Fruit juices with milk					-4.9	32.0
Flavoured milk			-9.8	12.7		

Notes: This table reports the own-price elasticities and margins (as a percentage of the price) by product categories for the non-alcoholic beverage market.

Table B.9: Elasticities and margins by sugar content - Biscuits market

	France		UK		Spain	
Sugar content (g/100g)	**Own-price elasticities**	**Margins (% price)**	**Own-price elasticities**	**Margins (% price)**	**Own-price elasticities**	**Margins (% price)**
[0 ; 10 [	-3.8	26.9	.	.	-4.7	26.5
[10 ; 20 [	-2.3	63.9	-4.8	37.4	-3.1	52.3
[20 ; 26 [	-2.6	53.6	-5.2	45.4	-2.8	63.9
[26 ; 31 [	-2.6	56.6	-5.8	31.9	-3.5	46.4
[31 ; 37 [	-2.6	60.1	-7.0	26.2	-5.2	26.9
[37 ; 43 [	-2.7	56.8	-7.7	17.9	-4.4	35.7
>= 43	-3.1	43.7	-7.7	22.9	-3.6	45.1

Notes: This table reports the own-price elasticities and margins (as a percentage of the price) by sugar content categories for the biscuit market.

Table B.10: Elasticities and margins by categories - Dairy desserts market

	France		UK		Spain	
Categories	**Own-price elasticities**	**Margins (% price)**	**Own-price elasticities**	**Margins (% price)**	**Own-price elasticities**	**Margins (% price)**
Yogurts	**-3.8**	**55.7**	**-3.7**	**38.9**	**-6.3**	**55.9**
plain	-2.7	66.6	-3.5	43.8	-5.8	62.5
other	-3.2	51.8	-3.7	38.5	-6.4	54.9
ODD	**-4.9**	**34.8**	**-5.0**	**29.9**	**-7.3**	**46.0**
FCPS	**-3.7**	**42.5**	**-4.2**	**33.6**		
plain	-3.4	47.7	-3.5	43.2		
other	-4.2	34.8	-4.3	32.4		

Notes: This table reports the own-price elasticities and margins (as a percentage of the price) by product categories for the dairy dessert market.

Table B.11: Own-price elasticities by markets, countries, and household characteristics

	Non-alcoholic beverages			Biscuits			Dairy desserts		
	France	**UK**	**Spain**	**France**	**UK**	**Spain**	**France**	**UK**	**Spain**
Household composition									
Without children	-4.71	-8.93	-7.39	-3.26	-9.28	-5.35	-3.08	-4.27	-3.05
With children <6	-4.64	-8.84	-7.21	-3.49	-9.19	-5.20	-3.00	-4.34	-3.13
With children 7-16	-4.67	-9.01	-7.69	-3.40	-9.12	-5.05	-2.98	-4.37	-3.19
With children <6 & 7-16	-4.59	-8.92	-7.51	-3.64	-9.04	-4.91	-2.98	-4.43	-3.25
Obesity status									
No overweight or obese	-4.48	-8.84	-7.42	-3.50	-9.18	-5.24	-2.97	-4.48	-3.26
At least one overweight or obese	-4.58	-8.95	-7.52	-3.28	-9.11	-4.99	-2.96	-4.39	-3.25
All overweight or obese	-4.89	-8.98	-7.42	-3.55	-9.19	-5.14	-3.00	-4.43	-3.24
Socio-economic class									
Rich	-4.06	-8.73	-7.24	-3.24	-9.04	-4.97	-3.17	-4.05	-2.82
Middle	-4.66	-8.96	-7.40	-3.42	-9.12	-5.04	-3.08	-4.18	-2.96
Poor	-5.24	-9.08	-7.71	-3.68	-9.31	-5.36	-3.01	-4.35	-3.16

Notes: This table reports the own-price elasticities by household characteristics for the three markets and the three countries. Own-price elasticities are calculated at the alternative level. For a given household characteristic, it is the mean elasticity computed across all the alternatives' own-price elasticities.

C Counterfactual calibration

C.1 2018 UK soda tax

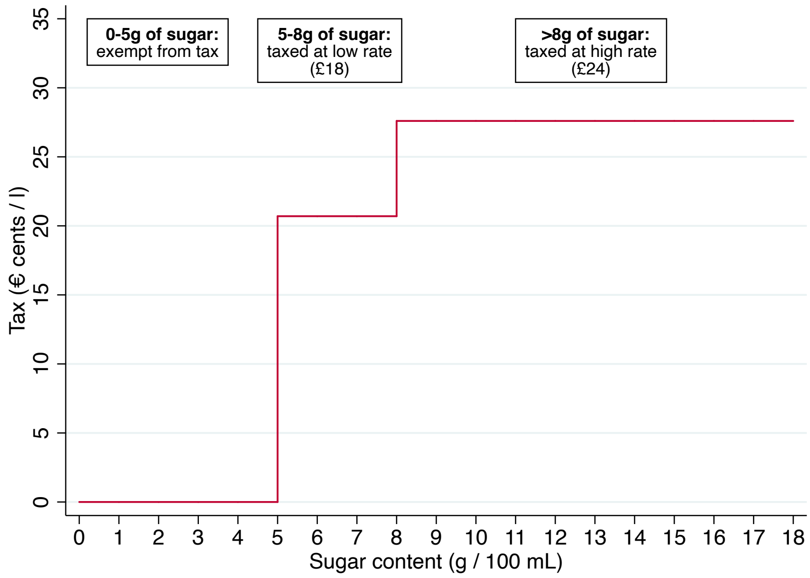
The UK government introduced the Soft Drinks Industry Levy (SDIL) in 2018. The levy is targeted at all soft drinks except pure fruit juices (which contain no added sugar) and drinks with a high milk content.

There are two levels of tax based on the sugar content:

- products with less than 5g of sugar per 100ml are exempt from the tax
- products with more than 5g and less than 8g of sugar per 100ml are taxed 0.18 GBP per liter
- products with more than 8g of sugar per 100ml are taxed 0.24 GBP per liter

The tax is not subject to the VAT tax.

Figure C.1: Design of the SDIL

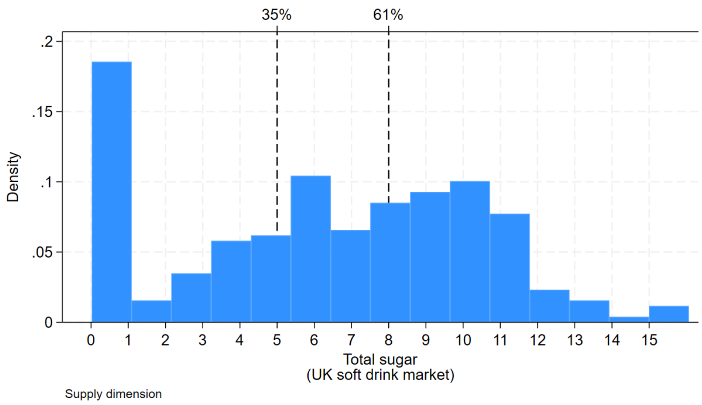


Notes: This figure describes the design of the SDIL implemented in the UK in 2018. The y-axis plots the tax rate (in euro cents per L) and the x-axis represents the sugar content of products (in grams per 100 mL).

C.2 Characteristics of the tax in the UK market

The average observed price of the targeted beverages in the UK soft drinks market is 6.5 cents per litre. Of these products (i.e., those containing added sugar but no milk), 35% have a sugar content below 5 g per 100 ml and are therefore exempt from the tax. Products with a sugar content between the 35^{th} and 61^{st} percentiles are taxed at the rate defined by the first threshold, while products with a sugar content above the 61^{st} percentile are taxed at the rate set by the second threshold.

Figure C.2: Distribution of targeted product



Notes: This graph shows the distribution of total sugar across the supply dimension. The distribution is calculated only for targeted products. The 35th and the 61st percentiles correspond to the location of the two sugar thresholds (at 5 and 8 grams of sugar per 100 mL of products) in the SDIL.

C.3 Equivalent policy design for other markets

To simulate an equivalent policy in the other eight markets, we adopt an design similar to the one implemented in the UK. The simulated tax will be a two-tiered tax based on sugar content. Thresholds will be set according to the sugar content of products in the relevant market. The first threshold will be set at the 35^{th} percentile in the distribution, and the second at the 61^{st} percentile in the distribution. As with the SDIL, the counterfactual policy will not be subject to VAT.

The amount of tax of product j containing added sugar will be obtained by the following formula:

$$\tau(\text{sugar}_j) = \begin{cases} 0 & \text{if sugar}_j < p35, \\ 0.18 \times 1.15 \times \frac{\text{mean price in the market}}{0.65} & \text{if } p35 \leq \text{sugar}_j < p61 \\ 0.24 \times 1.15 \times \frac{\text{mean price in the market}}{0.65} & \text{if } p61 \leq \text{sugar}_j \end{cases}$$

where

- $\tau()$ is the tax level (in € cents/L or kg) defined for each bracket of sugar content
- $p35$ and $p61$ = 35th and 61st percentiles in the distribution of total sugar across products containing added sugar (rounded down to the nearest integers)
- 0.18 and 0.24 = tax levels for the 1st and 2nd thresholds (in the SDIL, GBP/L)
- 1.15 = conversion rate GBP to euro
- 0.65 = mean price in the targeted soft drinks in the UK in 2017 (€ /L)

Table C.1 summarizes the tax scenario in each market and country.

Table C.1: Tax scenarios in the nine markets

	Mean price (€ / L)	**Ratio of prices**	**Sugar thresholds [p35 ; p61]** (g / 100 g or ml)	**Tax amount** (€ / L)
Non-alcoholic beverages				
UK	0.65	1	[5 ; 8]	[0.21 ; 0.28]
France	1.02	1.57	[8 ; 10]	[0.33 ; 0.43]
Spain	0.82	1.26	[8 ; 10]	[0.26 ; 0.35]
Biscuits				
UK	4.33	6.66	[27 ; 33]	[1.38 ; 1.84]
France	6.10	9.38	[29 ; 33]	[1.94 ; 2.59]
Spain	3.31	5.09	[20 ; 28]	[1.05 ; 1.41]
Dairy desserts				
UK	3.01	4.63	[11 ; 13]	[0.96 ; 1.28]
France	2.47	3.80	[12 ; 14]	[0.79 ; 1.05]
Spain	2.18	3.35	[11 ; 13]	[0.69 ; 0.92]

Notes: Column 2 provides the average price (in € per liter or kilogram) of targeted products in the market. Column 3 shows the ratio between the average price in column 2 and the average price of soft drinks targeted by the SDIL in the UK market. Column 4 lists the 35th and 61st percentiles of sugar content (in grams per 100 g or ml) for targeted products. Finally, column 5 presents the tax amounts for the two thresholds (in € per liter).

C.4 New price equilibrium

We simulate the impact on prices and consumption of a change in tax design. We denote $\tau = (\tau_1, \ldots, \tau_j, \ldots, \tau_{J_t})$ the vector of the amounts of the excise tax paid for each alternative j at period t in tax design d, and $\hat{c}_t = p_t - \gamma_t = (\hat{c}_{1t}, \ldots, \hat{c}_{j_t}, \ldots, \hat{c}_{J_t})$ estimated marginal costs vector, obtained from firms profit maximization conditional on demand parameters estimates (see Section B.2). We find the new equilibrium prices vector in period t, denoted $p_t^\star = (p_{1t}^\star, \ldots, p_{j_t}^\star)$, using the following optimizing programme:

$$\min_{\{p_{jt}^\star\}_{j=1,\ldots,J_t}} ||\underbrace{p_t^\star - \gamma_t^*(p_t^\star)}_{\hat{c}_t(p_t^\star)} - \tilde{c}_t|| \tag{15}$$

where $\tilde{c}_t = \hat{c}_t + \tau$ stands for the new marginal costs vector when the tax amounts vector is τ, and the function $\gamma_t^*(p_t^\star)$ is defined in equation (14).[12]

[12] To be in the same pre-tax conditions as in other markets, we have to remove the 2012 soda tax (0.0716€ $/L$), from the French non-alcoholic beverage market. First, we estimate the equilibrium prices following the removal of this tax. We then use these estimated prices as the "ex-ante" prices to evaluate the impact of the tax τ.

C.5 Change in welfare

We compute the change in different components of welfare resulting from the implementation of the tax.

Consumer surplus.

Let ΔCS be the annual variation in consumer surplus:

$$\Delta CS = CS(p^*) - CS(p) = \sum_{t=1}^{T}\sum_{d=1}^{D}\frac{M_t^d}{|\alpha_d|}\int\left(ln\frac{\sum_{j=1}^{J_t}\exp\delta_{djt}(p_t^*)}{\sum_{j=1}^{J_t}\exp\delta_{djt}(p_t)}\right)\mathrm{d}P_v(v) \tag{16}$$

where p_t^* is the vector of equilibrium prices after the tax, and p_t is the vector of observed equilibrium prices, and d is the household type defined by the combination of demographics used in the utility (see Table B.1), and M_t^d is the total market size in period t for households of type d.

Profit.

The annual variation in firms' profits at the market level is computed as follows:

$$\Delta\Pi = \Pi^* - \Pi = \sum_{t=1}^{T}\sum_{j=1}^{J}\Big(M_t(s_{jt}^*(p_t^*)\gamma_{jt}^*(p_t^*) - s_{jt}(p_t)\gamma_{jt}(p_t))\Big) \tag{17}$$

where M_t is the total market size in period t, $s_{jt}(p_t)$ is the market share of product j in period t, $\gamma_{jt}(p_t)$ is the margin of product j in period t, considering the price vector p_t. s_{jt}^* is the market share of product j in period t, $\gamma_{jt}^*(p_t)$ is the margin of product j in period t, considering the vector of equilibrium prices after tax, p_t^*.

Welfare.

The annual variation in welfare resulting from the tax is then:

$$\Delta WF = \Delta\Pi + \Delta CS + \Delta TR \tag{18}$$

where $\Delta TR = \sum_{t=1}^{T} M_t \sum_{j=1}^{J} s_{jt}^*(p_t^*)\tau$ is the annual tax revenue.

Welfare including health benefits. To consider the health benefits of a sugar tax, we internalise the social costs of sugar consumption into total welfare to account for the reduction in sugar consumption brought about by the tax. We calculate the social cost of total sugar consumption in the market as follows:

$$SC = ssc\sum_{t=1}^{T} M_t \sum_{j=1}^{J} s_{jt}(p_t) sugar_j \tag{19}$$

with ssc is the social cost of one kilogram of sugar, M_t the market size in period t, s_{jt} the market share vector and $sugar_{jt}$ the kg of sugar per kg of product. For the social cost of sugar, we use the value of $ssc = 12.833$ € per kg of sugar consumed estimated by Seidel et al. (2023), using data from Institute for Health Metrics and Evaluation (2022), Lara Castor et al. (2024), and von Philipsborn et al. (2023).

The annual variation in total welfare resulting from the tax, including the health benefits, is then:

$$\Delta WF = \Delta\Pi + \Delta CS + \Delta TR + \Delta SC \tag{20}$$

where $\Delta SC = SC^* - SC$ and $SC^* = ssc \sum_{t=1}^{T} M_t \sum_{j=1}^{J} s_{jt}^*(p_t^*) sugar_j$.