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► **To cite this version:**

Céline Bonnet, Vincent Requillart. Does the EU sugar policy reform increase added sugar consumption? An empirical evidence on the soft drink market. 19. European Workshop on Econometrics and health economics, Health Economics Resource Centre (HERC). GBR. University of York., Sep 2010, Lausanne, Switzerland. 27 p. hal-02813955

**HAL Id: hal-02813955**

**<https://hal.inrae.fr/hal-02813955>**

Submitted on 6 Jun 2020

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# Does the EU sugar policy reform increase added sugar consumption? An empirical evidence on the soft drink market.

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January 2011<sup>‡</sup>

## Abstract

Whereas National Health authorities recommend a decrease in the consumption of 'added' sugar, a reform on the Sugar Market will lead to a 36% decrease of the sugar price in the EU. Using French data on soft drinks purchases, this paper investigates the anticipated impact of this reform on the consumption of sugar sweetened beverages. The reform of the EU sugar policy leads to a decrease in regular soft drink prices by 3% and varies across brands. To assess substitution within this food category, we use a random-coefficients logit model that takes into account a large number of differentiated products and heterogeneity in consumers' behavior. Results suggest that price changes would lead to an increase in market shares of regular products by 7.5% and to substitutions between brands to the benefit of products with the highest sugar content. On the whole, it would raise consumption of regular soft drinks by more than 1 liter per person per year and consumption of added sugar by 124 grams per person per year, this increase being larger in households composed of overweight and obese individuals.

**JEL codes:** D12, I18, Q18.

**Key words:** differentiated products, soft drinks, sugar CMO, random coefficients logit model.

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<sup>‡</sup>We thank Marine Spiteri for helping us starting the project. We thank participants to the WEHE seminar in Lausanne and the EAEE-AAEA seminar in Freising as well as two anonymous referees for their comments. We declare that we have no conflicts of interest. Any remaining errors are ours.

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**(EU sugar policy reform and added sugar consumption)**

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Number of figures: 1

Number of tables: 6

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# 1 Introduction

In a recent paper, Schroeter *et al.* (2008) concluded that an 'efficient intervention (to combat obesity in the US) is to apply a tax on caloric soft drinks'. An on-going reform of the sugar policy in the European Union (EU) is going to reduce the EU price of caloric sweeteners by 36%. As sugar is the main variable input of the soft drink industry, the reform is the exact opposite of this recommendation. In this paper, we investigate the impact of the EU sugar policy reform on soft drink consumption and added sugar consumption, and discuss its likely effects on obesity.

In almost every developed country, obesity rates have significantly increased over the last decades (Sassi *et al.*, 2009). This is mainly due to a decrease in the price of food calories combined with an increase in the cost of burning calories (Cutler *et al.*, 2003). These price changes favoured an increase in caloric intake and a decrease in caloric utilisation which finally led to a weight increase.<sup>1</sup> Because obesity is now thought to be a major public health problem, public actions have been developed to combat the rise in obesity. Till now, they have mainly relied on information campaigns while pricing policies have been discussed but rarely implemented (Mazzochi *et al.*, 2009). Because food prices do depend on agricultural product prices, there is also a debate about the role of agricultural policies on the rise in obesity. For example, Lloyd-William *et al.* (2008) concluded that the EU agricultural policy led to a significant increase in cardiovascular mortality as the policy favoured the consumption of saturated fats. However, there is some controversy about the impact of agricultural policies because distortions created by agricultural policies vary significantly across products (see for example Alston *et al.*, 2006).

Over the last 20 years, the sugar price in the EU was well above the world market price. A combination of price floor, import duties, export subsidies and quotas were used to sustain the domestic price (European Commission, 2004). Moreover due to a restrictive quota, High Fructose Corn Syrup (HFCS) did not substitute for sugar in the EU as was the case in the US where the sugar policy also maintained high prices for sugar.<sup>2</sup> Thus in the EU the price of caloric sweeteners were high as compared to other

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<sup>1</sup>Other elements might explain the rise in obesity in the population such as a higher share of elderly in the population but it seems that the main factor is the change in prices and cost of using calories.

<sup>2</sup>For an analysis of competition between sugar and HFCS in the EU, see Cooper *et al.* (1995). For an analysis of the US sweetener market, see Beghin *et al.* (2003).

countries. The past sugar policy did not favour sugar consumption in the EU. However, in February 2006 a reform of the EU sugar policy was introduced which would lead to a significant decrease in the EU sugar price (Union Européenne, 2006). The reference price, which roughly acts as a floor price, is reduced by 36% over a 4-year period starting in 2006.<sup>3</sup> This reform is at odds with what would be recommended by nutritionists or public health authorities. For example, one objective of the French 'Programme National Nutrition Santé' is to decrease by 25% the consumption of added sugar (Ministère de la Santé et des Solidarités, 2006).

Therefore, while the health policy has set an ambitious objective of reduction of added sugar intake in the French population, the reform of the sugar policy in the EU will lead to a significant decrease in the price of sugar. If transmitted to the price of final sweetened products, the decrease in the sugar price might induce an increase in their consumption which could be detrimental for health. Thus, some empirical studies have focused on the relationship between food consumption and obesity and suggest that policies which increase the price of calories may provide useful tools to reduce caloric intake and therefore to reduce the prevalence of obesity (Jacobson and Brownell, 2000; Ransley *et al.*, 2003; Schroeter *et al.*, 2008; Bonnet *et al.*, 2009).

In the food and health economics literature most analysis of tax policies use a system of demand equations on broad food categories. Each equation specifies the demand for a food category as a function of its own price, the price of other food categories, and other variables (Chouinard *et al.*, 2007; Smed *et al.*, 2007; Leicester and Windmeijer, 2004, Marshall, 2000; Allais *et al.*, 2010; Etile, 2010; Bonnet *et al.*, 2009). These models do not allow for substitutions within a food category though it may be composed of highly differentiated products with different nutrient content that consumers may substitute.<sup>4</sup> Estimating demand for differentiated products with common demand models is nontrivial given the large number of parameters to be estimated. Moreover, these models do not allow for heterogeneity in consumer

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<sup>3</sup>The reference price for white sugar was 631.9€/t from 1 July 2006 to 30 September 2008. It was 541.5€/t from 1 October 2008 to 30 September 2009 and 404.4€/t after 1 October 2009. By comparison, in 2007, the average world market price of sugar was about 310€/t. In April 2010, the average price of sugar in the EU was 477 €/t while it was 636 €/t in 2006 which represents a 25% decrease. (<http://ec.europa.eu/agriculture/minco/manco/cmo/index.htm>)

<sup>4</sup>Whatever the coverage of the study, from the analysis of a complete demand system as in Bonnet *et al.* (2009) or Allais *et al.* (2010) to the analysis of a more specific market as in Chouinard *et al.* (2007) on dairy products where they distinguish about 10 dairy products, products within a category are assumed to be identical.

tastes and it is likely that preferences for products are not homogeneous across consumers. To tackle both problems, we propose to estimate a random-coefficients logit model that solves the problem of the number of parameters to be estimated by projecting products onto a space of characteristics (McFadden, 1973) and allows us to introduce heterogeneous preferences of consumers. Furthermore, the estimation method developed by Berry *et al.* (1995) and Nevo (2000) allows us to solve an omitted variables problem of prices. Indeed, prices are correlated with the error term of demand equations as unobserved characteristics included in the error term might be correlated with prices (e.g. advertising, promotions).

In this paper, we intend to assess the impact of the sugar price decrease on Soft Drink consumption in France taking into account heterogeneity of supply in the sugar-sweetened beverages (SSBs) industry. We choose this industry for three reasons. First, there is strong evidence that consumption of SSBs is a contributor to the ‘epidemic’ of obesity (Harnack *et al.*, 1999). Thus, in a systematic review of the impact of SSBs intake on weight gain, Malik *et al.* (2006) concluded by the following: "the weight of epidemiologic and experimental evidence indicates that a greater consumption of SSBs is associated with weight gain and obesity. Although more research is needed, sufficient evidence exists for public health strategies to discourage consumption of sugary drinks as part of a healthy lifestyle".<sup>5</sup> Any decrease in the price of SSBs would thus lead to an increase in their consumption which might have a negative impact on health. Second, according to AFSSA (2009), SSBs are the main source of caloric sweeteners intake for children (19.1%) and the third one for adults (13.3%). Third, sugar is an important input in this industry as the sugar content of SSBs ranges from 6% to 11%. Moreover, sugar costs range from 7 to 24% of the final price of SSBs. The anticipated 36% decrease in the price of sugar might have a significant impact on SSB prices.

This paper uses a structural econometric model that accounts for the heterogeneity in consumers’ preferences with respect to the different brands available and in particular according to demographic characteristics such as the proportion of overweight and obese individuals in a household. Hence, we will

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<sup>5</sup>One possible explanation of the physiological mechanism involved is the following: ‘consumption of sugar-sweetened drinks could lead to obesity because of imprecise and incomplete compensation for energy consumed in liquid form’ (Ludwig *et al.*, 2001; see also Malik *et al.*, 2006). There is some controversy whether HFCS is more detrimental than sugar (see for example Melanson *et al.*, 2007). However this does not significantly change the general conclusion that SSBs are a major contributor to the epidemic of obesity.

be able to account for different responses to price changes according to obesity status of households. We will also be able to distinguish different price changes as the sugar content of brands differs. Our results suggest that a larger proportion of overweight and obese individuals in a household is associated with a lower sensitivity to price changes. This implies that a decrease of SSB prices would have a larger impact on the percent change in consumption of households with 'thin' individuals. However, the consumption of households with obese people might increase more due to their initial higher consumption. The reform of the EU sugar policy might lead to a decrease in regular SSB prices by 3.4% on average and from 1.7% to 6.5% depending on the brand. The sugar price decrease would lead to an increase in market share of 7.5% for regular products and a decrease of 3.5% for diet products. This would imply an increase in regular soft drink consumption of 1.3 liters per person per year and an increase in added sugar consumption of 124 grams per person per year. Depending on the 'weight status' of the household, the average increase in per person consumption varies from 1.1 to 1.4 liters of soft drinks and from 116 to 141 grams of added sugar. The analysis also shows that the brands with the highest sugar content increase their market share by a larger proportion. The reform thus increases soft drink consumption but also induces a shift in favour of the products with the highest sugar content. This latter result fully justifies the use of a demand model with differentiated products to capture substitutions between products with different sugar content.

The paper is organized as follows. Section 2 presents the main characteristics of the soft drink market. Section 3 presents the data and descriptive statistics about soft drink consumption. Section 4 describes the demand model that allows us to assess own and cross-price elasticities. In section 5 we discuss demand results as well as the impact of the sugar policy reform. Finally we conclude in section 6.

## 2 The Soft Drink market

Soft drinks represent about 11% of total beverages consumption in France which includes mineral water, alcohol, coffee, tea, drinking milk as well as fruit juices (*Canadean, 2004*). On average, soft drink consumption increased by 32% from 1994 to 2004.<sup>6</sup> Nevertheless, per capita consumption in France (42.5

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<sup>6</sup>Note that the consumption of diet drinks increased by 224% from 1994 to 2004. Nevertheless, their market share is still lower than 20%.

liters per year) remains low as compared to per capita consumption in the EU (71.2 liters in average). Market analysts frequently distinguish between carbonated soft drinks or sodas – colas, tonics, carbonated fruit drinks, lemonade – and uncarbonated soft drinks – iced tea, fruits drinks. In France, carbonated soft drinks represent 78.5% of the market and uncarbonated soft drinks 21.5% in 2004. The three main categories are colas (54% of all soft drinks), fruit drinks (25% for both carbonated and non carbonated products) and iced tea (8%). Soft drinks do not include fruit juices and nectars which represent a significant part of beverage consumption. Those products do not contain a significant proportion of added sugar and they are thus not directly affected by the change in sugar price.<sup>7</sup> In our analysis, they are included in the 'outside' option for consumers as they are substitutes for soft drinks.

In general, there are two versions of each soft drink: a regular one which is sweetened using caloric sweeteners, almost exclusively sugar in France, and a diet one which is sweetened using non-caloric sweeteners such as aspartame or acesulfame. The two main ingredients of regular soft drinks are water (about 90%) and sweetener (about 10%). The main ingredient of a diet soft drink is water (99.7%). Obviously, soft drinks also contain food additives such as food coloring, artificial flavoring, emulsifiers and preservatives.

### 3 Data

We use consumer panel data collected by TNS WordPanel. We have a French representative survey of 19,000 households over a three year period (2003-2005). This survey provides information on purchases of food products (quantity, price, brand, characteristics of goods, store) and on characteristics of households (income, number of children and adults, weight and height of each person, ...).

According to our sample, the average total consumption of regular soft drinks per person per year is lower when households have no overweight and obese individuals. Indeed, consumption amounts to 32 liters per person per year in those households while it is 34 liters for households where some individuals are overweight or obese.<sup>8</sup> When all members of the household are overweight or obese, the consumption

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<sup>7</sup>Fruit juices do not contain added sugar while nectar contains less than 6% of added sugar.

<sup>8</sup>These figures are lower than the figure previously cited in section 2 because they only consider at home consumption.

rises to 37 liters per person per year (Table I). On average, consumers in households where all members are overweight or obese consume more of any category as the share of their consumption is higher than their proportion in the population. Not only have they consumed more diet products than the average consumer, but also more regular products and more 'outside option'.

From the panel data, we selected the 11 main national brands (NB) of the soft drink industry and three private labels (PL), one for each of the three categories of products (colas, iced tea, fruit drinks). We select the nine largest retailers in France. Those retailers are grocery store chains. They differ by the size of outlets as well as by the services they provide to consumers. Three retailers have mainly large outlets (larger than 2500 m<sup>2</sup>) located in suburbs. Two retailers have mainly intermediate outlets (from 400 to 2500 m<sup>2</sup>) mainly located near small cities. Two retailers have both large and intermediate size outlets. Finally the last two are discounters with outlets of small to intermediate size. Taking into account the set of products carried by each retailer we get 105 (or 104 depending on the period) differentiated products which compete on the market.<sup>9</sup>

Market shares are defined as follows. The relevant market is the whole market of SSBs including soft drinks, fruit juice and nectar. Then, market share of a given brand in a given retailer is defined as the ratio of the sum of purchases of the brand in the selected retailer during a period of four weeks over the sum of purchases of all brands in all retailers in the relevant market during the same period. In this setting, the outside option (which represents 66% of the whole market) is composed of two elements: purchases of fruit juice and nectar (40% of the market) on the one hand and purchases of non selected soft drinks or non selected retailers on the other hand.<sup>10</sup>

INSERT Table I ABOUT HERE

INSERT Table II ABOUT HERE

Selected soft drinks account for 33.8% of the whole market (Table II). The average price over products and periods is 0.82 euros per liter. Regular products dominate the market as they represent about 80%

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<sup>9</sup>From the consumer perspective, a product is the combination of a brand and a retailer. We account for this precise differentiation because prices differ by retailer. Moreover, the sugar content of private labels also varies across retailers.

<sup>10</sup>We exclude 77 brands as well as 66 retailers or distribution channels. All those only represent 27% of the market.

of soft drink purchases; their prices are 15% lower than those of diet products. PLs hold about 27% of the soft drink market and are sold at about half of the price of NBs. Soft drinks also differ by their sugar content (Figure 1). The sugar content is 0 for diet products and varies from 56 to 110g per liter for regular brands.

INSERT Figure 1 about HERE

## 4 The Demand Model: a random-coefficients logit model

To get price elasticities of demand for every differentiated product we need a demand model as flexible as possible and thus opt for a random-coefficients logit model (Berry *et al.*, 1995; McFadden and Train, 2000). This model is based on a random utility specification that takes into account the observed and unobserved heterogeneity in consumers' preferences. Moreover, this discrete choice model allows us to account for product differentiation in an easy way since it allows us to project the large number of products on a space of characteristics (McFadden, 1973).

The indirect utility function  $V_{ijt}$  for consumer  $i$  buying product  $j$  in period  $t$  is given by

$$V_{ijt} = \beta_j + \gamma_t - \alpha_i p_{jt} + \rho_i l_j + \xi_{jt} + \varepsilon_{ijt}$$

where  $\beta_j$  are product fixed effects which capture the (time invariant) unobserved product characteristics,  $\gamma_t$  are time fixed effects (dummies) which capture time demand shocks,  $p_{jt}$  is the price of product  $j$  in period  $t$  and  $\alpha_i$  the marginal disutility of price for consumer  $i$ ,  $l_j$  is a dummy related to an observed product characteristic (which takes 1 if product  $j$  is a diet product and 0 otherwise) and  $\rho_i$  captures consumer  $i$ 's taste for the diet characteristic,  $\xi_{jt}$  captures the unobserved variation in product characteristics and  $\varepsilon_{ijt}$  is an unobserved individual-specific error term.

We assume that  $\alpha_i$  and  $\rho_i$  vary across consumers. Indeed, consumers may have a different price disutility or different tastes for the diet characteristic. We assume their distributions are independent and parameters have the following specification:

$$\begin{pmatrix} \alpha_i \\ \rho_i \end{pmatrix} = \begin{pmatrix} \alpha \\ \rho \end{pmatrix} + \Pi D_i + \Sigma v_i$$

where  $D_i$  is a  $d \times 1$  vector of demographics and  $v_i = (v_i^\alpha, v_i^\rho)'$  a  $2 \times 1$  vector which captures the unobserved consumers characteristics.  $\Pi$  is a  $2 \times d$  matrix of coefficients that measure the taste characteristics through demographics and  $\Sigma$  is a  $2 \times 2$  diagonal matrix of parameters  $(\sigma_\alpha, \sigma_\rho)$  that measure the unobserved heterogeneity of consumers. We suppose that  $P_v(\cdot)$  is a parametric distribution of  $v_i$ ,  $P_D(\cdot)$  is a non parametric distribution known from data and  $D_i$  and  $v_i$  are independant. This specification allows demographics to affect taste characteristics, reducing the reliance on parametric assumptions.

We can break down the indirect utility into a mean utility  $\delta_{jt} = \beta_j + \gamma_t + \alpha p_{jt} + \rho l_j + \xi_{jt}$  and a deviation from this mean utility  $\mu_{ijt} = [p_{jt}, l_j] (\sigma_\alpha v_i^\alpha + \pi_\alpha D_i, \sigma_\rho v_i^\rho + \pi_\rho D_i)'$ . The indirect utility is given by  $V_{ijt} = \delta_{jt} + \mu_{ijt} + \varepsilon_{ijt}$ .

The consumer may decide not to choose one of the products considered. Thus, we introduce an outside option allowing for substitution between the considered products and a substitute. The utility of this outside good is normalized to zero. The indirect utility of choosing the outside good is  $V_{i0t} = \varepsilon_{i0t}$ .

Assuming that  $\varepsilon_{ijt}$  is independently and identically distributed like an extreme value type I distribution, we are able to write the market share of product  $j$  in period  $t$  in the following way (Nevo, 2001):

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

where  $A_{jt}$  is the set of consumers who have the highest utility for product  $j$  in period  $t$ , a consumer is defined by the vector  $(D_i, \nu_i, \varepsilon_{i0t}, \dots, \varepsilon_{iJt})$ . We assume that the distribution  $P_\nu$  follows an independant bivariate normal distribution with means  $\alpha$  and  $\rho$  and standard deviations  $\sigma_\alpha$  and  $\sigma_\rho$  of  $v_i^\alpha$  and  $v_i^\rho$  respectively.

As the product market share is a multiple integral, we are not able to compute it. We then use a simulation method to approximate it and can write the following simulated market share:

$$s_{jt} = \frac{1}{R} \sum_{r=1}^R \frac{\exp(\delta_{jt} + [p_{jt}, l_j] (\sigma_\alpha v_r^\alpha + \pi_\alpha D_r, \sigma_\rho v_r^\rho + \pi_\rho D_r)')}{1 + \sum_{k=1}^{J_t} \exp(\delta_{kt} + [p_{jt}, l_j] (\sigma_\alpha v_r^\alpha + \pi_\alpha D_r, \sigma_\rho v_r^\rho + \pi_\rho D_r)')} \quad (2)$$

where  $R$  is the number of draws of distributions  $P_\nu$  and  $P_D$ ,  $D_r$  is the vector of observed demographics for household  $r$ , and  $v_r^\alpha$  and  $v_r^\rho$  are the  $r^{th}$  draws of the independant bivariate normal distribution  $P_\nu$ . We

estimated the parametric distribution of unobserved consumer characteristics using 500 draws. We also used 500 draws to estimate the non parametric distribution of consumer demographics (i.e. the proportion of overweight and obese people as well as the proportion of obese people).  $P_\nu$  and  $P_D$  are supposed to be constant over a time period  $t$ .

The random-coefficients logit model generates a flexible pattern of substitutions between products driven by the different consumer price disutilities  $\alpha_i$ . Thus, the own and cross-price elasticities of the market share  $s_{jt}$  can be written as:

$$\frac{\partial s_{jt}}{\partial p_{kt}} \frac{p_{kt}}{s_{jt}} = \begin{cases} -\frac{p_{jt}}{s_{jt}} \int \alpha_i s_{ijt} (1 - s_{ijt}) dP_\nu(\nu) dP_D(D) & \text{if } j = k \\ \frac{p_{kt}}{s_{jt}} \int \alpha_i s_{ijt} s_{ikt} dP_\nu(\nu) dP_D(D) & \text{otherwise.} \end{cases} \quad (3)$$

## 5 Results

In this section, we present and discuss demand results as well as the results of the policy simulation.

### 5.1 Demand results

We estimate the random-coefficients logit model using the well-known GMM method proposed by Berry *et al.* (1995) and Nevo (2000, 2001). This method requires the use of a set of instruments to solve an omitted variables problem. Indeed, prices may be correlated with the error term of demand equations as unobserved characteristics included in the error term might be correlated with prices (e.g. advertising, promotions). In order to get unbiased price effects, we choose instruments affecting the marginal cost curve. Then if the level of unobserved factors like advertising or promotion changes, thus affecting the demand, the estimated price is not affected. In practice, we use input price indexes of wages, plastic, aluminium, sugar and gazole as it is unlikely that input prices are correlated with unobserved demand determinants.<sup>11</sup> These variables are interacted with manufacturers dummies because we expect that manufacturers obtain from suppliers different prices for raw materials and the quality of plastic and aluminium may change over manufacturers.

Table III shows results of the demand model estimates by GMM accounting for consumer heterogeneity in the sensitivity of price and in taste for observed product characteristics. First, note that the

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<sup>11</sup>These indexes are from the French National Institute for Statistics and Economic Studies.

overidentifying restriction test is not rejected meaning that instruments are valid. On average, the price has a significant and negative impact on utility. The proportion of overweight and obese individuals in a household affects positively the price coefficient meaning that these households are less price sensitive. Proportion of obese in the household does not significantly influence the price sensitivity of households. Combined with the previous result, it means that overweight and obese people do not behave differently. Furthermore, the coefficient on the dummy identifying diet products is positive on average meaning that consumers like this characteristic. However, the standard deviation is large meaning that some consumers do not like diet products while some others like them. The proportion of overweight and obese individuals and the proportion of obese individuals have no impact on the coefficient of the diet characteristic.

INSERT TABLE III ABOUT HERE

From the structural demand estimates, we are able to compute own and cross-price elasticities for each of the differentiated products (Table IV).<sup>12</sup> As we used a logit model, elasticities reflect the likelihood of households to switch from a differentiated product to another one. Given the market includes the 'outside option', the market of soft drinks which is under scrutiny is then not constant. Consumers can thus switch from a differentiated soft drink to the outside option and vice versa. Therefore, the model takes into account a volume effect in soft drink consumption. The own-price elasticities of demand for a brand varies between -2.92 and -4.37 and is -3.93 on average. Our results suggest that demand for regular products is slightly less elastic than demand for diet products (diet products are brands 2, 4, 6 and 9). Thus, own-price elasticity of demand for regular brands is about -3.87 while it is about -4.08 for diet brands, these means are statistically different. Finally, PL demand is less price elastic than NB demand. The same magnitude of own-price elasticities are obtained by other studies of the soft drink market in the US, specially if one takes into account the way brands are defined. Obviously, price elasticity of demand for a 'product' does depend on the definition of the product. A priori, the more brands are distinguished

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<sup>12</sup>To built this table we compute the elasticities of brands within each retailer and we report the average over the different retailers of each elasticity and overtime. To do so we compute the matrices of elasticities for each retailer. Except in the case of discounters which sold very few products (mainly their private labels and very few national brands), there is no evidence of significant differences among the matrices of elasticities calculated at the retailer level. Thus we only report the average value of elasticities. Own price elasticities of brands 13 and 14 in discount retails are lower (-2.65 and -2.45 respectively). As those retailers only sell a limited range of products, substitution among brands is very limited which explains that the demand for the corresponding products is less elastic.

in the analysis the higher the elasticity of a single brand. Thus, Gasmi *et al.* (1992) estimated own-price elasticities to -2 for Coca-Cola and Pepsi-Cola. For the Carbonated Soft Drink US market, Dhar *et al.* (2005) distinguished 4 brands and found own-price elasticities between -2 and -4. However, using a higher level of disaggregation (about 20 brands) for the US market, Dubé (2005) found elasticities ranging from -3 to -6.<sup>13</sup>

The analysis of cross-price elasticities among products in a given retailer reveals that substitutions are mainly among products with similar sugar profiles, that is regular products (i.e. those sweetened with caloric sweeteners) substitute for other regular products rather than with diet products. Conversely, diet products substitute more with other diet products than they do with regular products. The taste category (cola, ice tea, fruit drinks) does not seem to play a significant role in the substitutions as substitution within a taste category are not larger than between categories. We also analyse the possibility for consumers to switch from one retailer to another one. Results suggest that, at least for leading brands, consumers prefer to switch of retailer in order to buy their preferred brand rather than switching of brands within a given retailer.

Finally, we are able to compute the own price elasticities for households with different demographic characteristics. As a consequence of the positive coefficient of price for the proportion of overweight and obese people in an household, we find average own price elasticities varying from -5.49 to -3.14 when the proportion of overweight and obese individuals in the household increases. Then, household with overweight and obese people will react less to a change in the brand price. A decrease in regular product prices in response to the foreseen decrease in sugar price is likely to induce a larger (in percent) increase in the consumption of soft drinks by households without overweight and obese people than by households with overweight and obese people .

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INSERT TABLE IV ABOUT HERE

<sup>13</sup>Unfortunately, according to our knowledge, there is no other study on the French soft drink market.

## 5.2 Simulation of the sugar policy reform

In line with the anticipated impact of the reform of the EU sugar policy, we simulate a 36% decrease in the sugar price. Using the sugar content of each product, we calculate the decrease in cost due to the price cut of sugar. On average, the decrease of sugar price generates a decrease in the production cost of 2 € cents per litre for regular products. Depending on the sugar content, the decrease varies from 1.79 to 2.68 € cents per litre (see Table IV). Assuming full transmission of the production cost decrease to the final price, consumer prices of regular products decrease by more than 3.4% on average. Price changes are heterogenous (from -1.7% to -6.5%) as both cost reduction and initial prices are different among products. In particular, as PLs are priced about 50% lower than NBs, the percent decrease in the PL prices is higher.

### 5.2.1 Impact on market shares

A decrease in the price of regular products leads to an increase of 7.5% in the aggregate market share of regular products. This is due to substitution with diet products (whose market share decreases by 3.5%) as well as with the outside option (whose market share decreases by 3%).<sup>14</sup> We find that changes in market share are very heterogeneous across brands (Table V). Private labels as well as brands 1 and 3 manage to get larger increases. This result suggests that taking into account the differentiation of products in a food category is important. In particular, it is interesting to note that among NBs it is brands with the highest sugar content which experience the largest increase in market share. PLs also significantly increase their market shares. On average they have a lower sugar content but their composition is not homogenous as PLs are different from one retailer to another one. It is also worth noting that when market share is evaluated in percentage points (rather than in %) brand 3 which has a 'high' sugar content has the largest increase in market share. Thus, not only is there substitution between

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<sup>14</sup>It should be acknowledged that the price of the outside option is assumed to be unchanged which is a limit in the analysis. However, a significant part of the goods in the outside option will not be affected by the decrease in the sugar price as those goods do not contain any added sugar.

regular and diet products but also among regular products there is substitution toward products with the highest sugar content.<sup>15</sup>

INSERT TABLE V ABOUT HERE

### 5.2.2 Impact on households

Since our demand estimates take into account different price sensitivities according to the obesity status of the household, we are able to recover the change in the average consumption of different groups of households. Table VI provides the increase in average consumption of regular and diet products as well as the increase in the consumption of added sugar for three groups of households.

The average consumption of regular products increases by 1.16 liters while the average consumption of diet products remains roughly identical. Consumption of added sugar would increase by 124 grams per person per year. However, the presence of overweight or obese individuals in the household plays a role. For households where less than half of the members are overweight and obese, the increase is about 1.3 liters of regular soft drinks and 141 grams of added sugar, which are statistically different from the results of an average household.

We estimated the increase in added sugar consumption using two methods. The first one takes into account the true sugar content of each brand (fifth column). The second one assumes an average sugar content (sixth column). The first estimate is on average 5% higher than the second (from 4% to 6% depending on households). Thus all else constant (in particular the change in market share of each brand), the substitution in favour of brands with a high sugar content increases added sugar consumption by 5%.

INSERT TABLE VI ABOUT HERE

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<sup>15</sup>As mentioned by a referee, this substitution might be the consequence of two mechanisms: as brands experience different price drops (the higher the sugar content the larger the decline in price), consumers might first switch between brands to the benefit of products with the highest sugar content; second consumer might buy more of a specific brand because its price decreases. As the model is estimated using aggregate data, we cannot distinguish between these two mechanisms.

## 6 Conclusion

The EU sugar policy reform will have induced a significant decrease in the price of sugar. This reform is at odds with what is recommended by health authorities who to combat obesity have called for a decrease in the consumption of added sugar. To anticipate the impact of the sugar policy reform on added sugar consumption we focused our analysis on a specific sector, the soft drink industry which is frequently denounced as a significant contributor to the obesity problem. We argue that such an analysis should take into account the existence of numerous and highly differentiated products in the food market. Using a very flexible demand model, we are able to simulate the impact on soft drink consumption of the recent EU reform of the sugar market. Our results suggest that 1) the expected 36% reduction in the sugar price might induce an increase in the consumption of regular soft drinks of 7.5% while the consumption of diet products would be slightly reduced; 2) the decrease in sugar price not only increases the aggregate market share of regular soft drinks but also favors products with the highest sugar content; the increase in added sugar consumption is thus due to the increase in consumption of soft drinks and to the substitution between brands in favor of the most sweetened; 3) the larger the proportion of overweight and obese individuals in a household, the less sensitive to change in prices consumers are; as households with a higher proportion of overweight and obese people have a larger initial consumption of soft drinks, the change in consumption among households is less variable than the initial consumption.

In this analysis we have assumed that the cost reduction is fully transmitted to consumer prices. This implicitly assumes marginal cost pricing through the vertical chain. Depending on how cost changes are transmitted to the final prices, this might lead to over or under estimates of the impact of the reform. In France, Campa and Golberg (2006) showed that the retail price transmission is greater than 1 in the food retailing industry. According to this result, assuming a 1 to 1 cost price transmission leads to an underestimate of the impact of the reform.

The quantitative changes in sugar consumption might be considered to be small or even negligible. We argue it is not the case for two reasons. First, it should be acknowledged that the SSB consumption

in France is lower than in the rest of Europe. For example, SSB consumption in the UK is larger than 100 l/person/year which is 2.5 times the consumption in France. As the sugar policy reform applies to all EU countries, in countries like the UK, the impact on sugar added consumption is likely to be significantly higher. Second the sugar policy reform will affect the markets for all sweetened products while here we focused on a specific market. So the impact on consumption of added sugar is likely to be larger. In any case, from a health perspective, the reform goes in the wrong direction.

Finally, if one considers that SSBs play a significant role on the epidemic of obesity, our results suggest that taxing SSBs could help combat obesity. Our results also suggest that the tax should be set in relation to sugar content in order to avoid substitution in favor of products with high sugar content.

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**Table I:** Descriptive Statistics on households' consumption and related market shares

Proportion of overweight and obese in households	Proportion of households (%)	Proportion of consumers in households (%)	Consumption of regular soft drinks (liter/person.year)	Market share (%)		
				Soft Drinks Regular	Diet	Outside option
No	44	39	31.8	35*	32	39
Less than half	35	43	34.5	45	40	41
More than half	21	18	37.0	20	28	20
Total	100	100		27.3**	6.5	66.2

\*: this means that consumers in households with no overweight or obese people buy 35% of the regular products

\*\*: this means that the market share of regular products is 27.3%

**Table II:** General Descriptive Statistics for Prices and Market Shares

	Prices (in euros per liter)	Market Shares
	Mean (std)	Mean in %
Outside Good		66.2
Soft Drinks	0.82 (0.25)	33.8
Regular products	0.78 (0.26)	80.8
Diet products	0.92 (0.16)	19.2
National brands	0.93 (0.153)	73.1
Private labels	0.47 (0.13)	26.9

**Table III:** Results for the random coefficients logit model

Coefficients (Std. error)	Mean	Standard Deviation
Price	-8.55 (1.57)	2.52 (0.95)
Proportion of overweight and obese people	6.50 (1.92)	
Proportion of obese people	-6.32 (7.02)	
Diet	1.04 (0.08)	2.20 (0.86)
Proportion of overweight and obese people	2.72 (2.63)	
Proportion of obese people	4.93 (3.71)	
Coefficients $\delta_j, \gamma_t$ not shown		
Overidentifying Restriction Test (df)	26.11 (17)	

**Table IV:** Own and Cross Price Elasticities between Brands within the same Retailer

	Brand1	Brand2	Brand3	Brand4	Brand5	Brand6	Brand7	Brand8	Brand9	Brand10	Brand11	Brand12	Brand13	Brand14
Sugar	R	D	R	D	R	D	R	R	D	R	R	R	R	R
Categ.	1	1	1	1	2	2	3	3	3	3	3	1	2	3
Brand1	-4.2078	0.0029	0.0044	0.0019	0.0040	0.0016	0.0041	0.0038	0.0017	0.0045	0.0044	0.0063	0.0062	0.0062
Brand2	0.0049	-4.3676	0.0043	0.0358	0.0039	0.0268	0.0040	0.0037	0.0289	0.0043	0.0043	0.0047	0.0046	0.0046
Brand3	0.1303	0.0531	-4.1961	0.0563	0.1274	0.0524	0.1291	0.1217	0.0545	0.1339	0.1336	0.0965	0.1132	0.1084
Brand4	0.0348	0.2791	0.0361	-4.0739	0.0352	0.1958	0.0356	0.0344	0.2084	0.0358	0.0360	0.0261	0.0298	0.0288
Brand5	0.0161	0.0066	0.0173	0.0074	-4.0720	0.0072	0.0175	0.0170	0.0075	0.0172	0.0173	0.0103	0.0130	0.0119
Brand6	0.0022	0.0147	0.0024	0.0138	0.0025	-3.8166	0.0025	0.0025	0.0126	0.0024	0.0024	0.0014	0.0018	0.0016
Brand7	0.0155	0.0063	0.0166	0.0071	0.0165	0.0068	-4.0960	0.0161	0.0071	0.0165	0.0166	0.0102	0.0128	0.0118
Brand8	0.0150	0.0061	0.0164	0.0072	0.0168	0.0071	0.0169	-3.8687	0.0073	0.0163	0.0165	0.0090	0.0117	0.0106
Brand9	0.0074	0.0507	0.0079	0.0465	0.0081	0.0398	0.0082	0.0081	-4.0222	0.0079	0.0080	0.0049	0.0059	0.0055
Brand10	0.0171	0.0070	0.0176	0.0073	0.0165	0.0068	0.0167	0.0158	0.0071	-4.3028	0.0174	0.0132	0.0150	0.0143
Brand11	0.0101	0.0041	0.0105	0.0044	0.0100	0.0041	0.0101	0.0096	0.0043	0.0104	-4.2762	0.0072	0.0087	0.0082
Brand12	0.0112	0.0052	0.0054	0.0023	0.0040	0.0017	0.0044	0.0037	0.0019	0.0054	0.0052	-2.9243	0.0119	0.0119
Brand13	0.0084	0.0037	0.0063	0.0026	0.0053	0.0021	0.0055	0.0048	0.0023	0.0063	0.0062	0.0096	-3.6356	0.0091
Brand14	0.0184	0.0081	0.0146	0.0060	0.0119	0.0048	0.0125	0.0108	0.0052	0.0147	0.0142	0.0199	0.0190	-3.4884

R means regular; D means diet

**Table V:** Simulation of a decrease by one third decrease of the sugar price

	Sugar Content (in grams per liter) Mean (std)	Change in cost (€ cents) Mean (std)	Change in price (%) Mean (std)	Change in MS (points) Mean (std)	Change in MS (%) Mean (std)
Brand 1	110 (.)	2.68 (0.05)	-3.69 (0.50)	+0.09 (0.01)	10.25 (1.85)
Brand 2	–	–	–	-0.03 (0.01)	-3.74 (0.50)
Brand 3	103 (.)	2.58 (0.05)	-2.94 (0.16)	+0.77 (0.06)	7.32 (0.93)
Brand 4	–	–	–	-0.15 (0.02)	-3.59 (0.50)
Brand 5	73.6 (0.36)	1.79 (0.12)	-1.73 (0.14)	0.02 (0.01)	1.93 (0.73)
Brand 6	–	–	–	-0.01 (0.00)	-3.12 (0.72)
Brand 7	90 (.)	2.19 (0.04)	-2.16 (0.23)	0.04 (0.01)	3.77 (1.05)
Brand 8	105 (.)	2.55 (0.05)	-2.28 (0.16)	0.05 (0.01)	4.23 (0.92)
Brand 9	–	–	–	-0.03 (0.01)	-3.34 (0.56)
Brand 10	92 (.)	2.24 (0.04)	-2.61 (0.21)	0.08 (0.02)	5.73 (0.94)
Brand 11	102 (.)	2.48 (0.05)	-2.75 (0.25)	0.05 (0.01)	6.43 (1.30)
Brand 12	95 (15)	2.32 (0.39)	-6.55 (2.00)	0.52 (0.04)	14.60 (4.30)
Brand 13	76 (27)	1.86 (0.07)	-3.69 (1.00)	0.17 (0.04)	7.78 (1.58)
Brand 14	89 (59)	2.16 (0.15)	-4.52 (0.83)	0.45 (0.06)	10.84 (1.63)

**Table VI:** Change in consumption for different groups of households (liter or gram/person/year)

Percentage of overweight and obese households	Proportion of households (%)	Regular Soft Drinks Mean (std) (l/p/year)	Diet Soft Drinks Mean (std) (l/p/year)	Added Sugar Differentiated (1) (g/p/year)	Added Sugar Average(2) (g/p/year)
No	44	1.19 (0.06)	-0.00 (0.00)	116	112
less than half	35	1.42 (0.08)	-0.03 (0.01)	141	133
More than half	21	1.16 (0.10)	-0.47 (0.06)	116	109
Total Population	100	1.16 (0.07)	-0.11 (0.01)	124	118

(1): Taking into account the sugar content of each brand (2) Using an average content

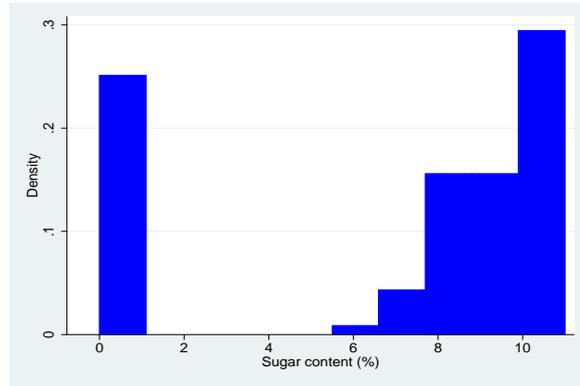


Figure 1:

**Figure 1:** Distribution of sugar content of soft Drink products