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Abstract

National Health authorities recommend a decrease in the consumption of 'added' sugar. At the same moment, a reform of the Common Organisation of the Sugar Market will lead to a decrease by more than 30% of the sugar price in the EU. Using the example of the soft drink industry, this paper investigates the impact of that reform on the consumption of sugar sweetened beverages. Because the soft drink industry as well as the retail industry are both highly concentrated, using structural econometrics model, we first estimate models of vertical relationships between the beverage industry and the retail industry. After selecting the 'best' model of vertical relationships, we then simulate the impact of the decrease in sugar price on prices and consumption for different categories of consumers. We also study the impact of setting taxes on soft drink as it was recently proposed in order to counterbalance the impact of the sugar policy reform. Using French data on the Soft Drinks purchases, we find that this reform could decrease prices by 5% and increase market shares of regular products by 8% that would rise the consumption of regular soft drink by more than 1 liter per year and per person. The increase in per person consumption is larger in households composed of overweight and obese individuals. A tax of 6 cents on high sugar content products and 3 cents on low sugar content products might more than annihilate the effect of the sugar price decrease. In average, the combination of the sugar policy reform and the additional tax might provoke a decrease in the average consumption of regular soft drinks by and would fall the consumption of regular soft drinks by about 1.9 liters per person. The policy reforms have also some impact on the demand of diet products as there is some substitution between regular and diet products.

JEL codes:

Key words: vertical contracts, two part tariffs, competition, manufacturers, private labels, retailers, differentiated products, soft drinks, non nested tests,sugar CMO, passthrough.

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1 Introduction

In a recent paper, Schroeter et al. (2008) conclude that 'a relative 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 EU is going to reduce the EU price of caloric sweeteners by 1/3. As sugar is the main variable input of the soft drink industry, this policy reform is the exact opposite to this recommendation. In this paper, we investigate the impact of this reform on soft drink consumption and discuss its likely effects on obesity.

In almost every developped countries, 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 calories intake and a decrease in calories utilisation which finally led to a weight increase.[1] Because obesity is now thought as a major public health problem, public actions are developped in order to combat obesity rise. Till now, it mainly relies on information campaign while pricing policies are discussed but are rarely put in place (Mazzochi, Traill and Shogren, 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. There is no clear evidence about the impact of agricultural policies certainly because distorsions created by agricultural policies vary significantly across products (see for example Alston et al., 2006).

Over the last 20 years, sugar price in the European Union (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 restrictive quota, High Fructose Corn Syrup (HFCS) did not substitute for sugar in the EU as it was the case in the US where the sugar policy also maintained high prices for sugar.[2] Thus in the EU the price of caloric sweeteners were high as compared to other countries. In February 2006 a reform of the EU sugar policy was agreed (Union Européenne, 2006). This reform will lead to a significant decrease in the EU sugar price. The reference price, which roughly acts as a floor price, will be reduced by 36% over a 4-year period starting in 2006.[3]

[1] Other elements might explain the rise in obesity in the population such as a higher share of olders in the population but it seems that the main ingredient is the change in prices and cost of using calories.

[2] For an analysis of competition between sugar and HFCS in the EU, see Cooper et al. (1995). For an analysis of the US market, see Beghin et al. (2003).

[3] The reference price for white sugar is 631.9 /t from 1 July 2006 to 30 September 2008. It is 541.5 /t from 1 October

This reform is at odds of what would be recommended by nutritionnists or public health consideration. For example, one of the 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 products, this price decrease 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, Dubois and Orozco, 2009).

A limit of these analysis is the absence of strategic reaction of both producers and retailers which are supposed not to adjust prices of the products. In circumstances that depart from a perfect competition framework this might be an important limitation in the analysis. Thus, both the food industry and the retail food industry are characterised by large firms with market power, and therefore taxes and subsidies are unlikely to be fully passed through. Economic studies on retail pass-through of upstream cost changes (due to input taxes or cost shocks) show they can be incomplete (Bettendorf and Verboven, 2000; Goldberg and Verboven, 2001; Nakamura and Zerom, 2010; Goldberg and Hellerstein, 2008; Hellerstein and Villas-Boas, 2008; Bonnet, Dubois and Villas Boas, 2009). Moreover, the share of input considered in the production cost of products plays an important role in the transmission of a tax. Overall, the impact on final prices of a price change on input will be heavily influenced by firms' behaviour.

In this paper, we intend to identify the retail price transmission of a decrease in the price of an input (sugar in this case) of food products taking into account the vertical relationships between food processors and retailers. From changes in consumer prices, we then deduce the impact on consumption distinguishing among different categories of consumers. We apply this methodology to the French soft drinks industry.

2008 to 30 September 2009 and it is 404.4 /t after 1 October 2009. As a comparison, in 2007, the average world market price of sugar was about 310 $/t.

We choose this industry for three reasons. First, there is strong evidence that consumption of sugar-sweetened beverages (SSBs) is a contributor to the 'epidemic' of obesity (Harnack, Stang and Story, 1999). Thus, in a systematic review of the impact of SSBs intake on weight gain, Malik et al. (2006) conclude 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".[4] Any decrease in the price of SSBs would thus leads to an increase in their consumption which might have a negative impact on health. Second, 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 significant impact on SSBs prices. Third, as part of the debate on health policy in France, some delegates have recently proposed to implement a tax on SSBs based on their sugar content.

The originality of our approach is to deal with a vertical chain composed of oligopolies. The soft drink industry is highly concentrated as well as the retail industry. It is thus needed to deal with imperfect competition in the industry and to analyse how a significant change in the price of an input is transmitted to the final consumers. This is needed in order to precisely assess what is the likely impact of the change in the upstream regulation on the final consumption of these products.

This paper uses structural econometric models that allow to account for the structure of the industry, and in particular the horizontal and vertical interactions between manufacturers and retailers. From estimates of consumers' demand on the French soft drink market, we recover price cost margins from several supply models as in Berto Villas-Boas (2007) and Bonnet and Dubois (2010). Using exogenous cost variables, we simulate a sugar price decrease and analyse the impact on prices and market shares of the various SSBs. We also perform alternative policy simulations such as a taxation of SSBs that would limit or annihilate the decrease in consumer prices of SSBs. We account for heterogeneity in consumers'

[4] 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.

preferences and particularly demographic characteristics such as the proportion of overweight and obese individuals in a household in order to take into account different responses to price changes according to obesity status of households. Our results suggest that the larger the proportion of overweight and obese individuals in a household, the less sensitive to change in prices consumers are. This implies that a decrease of SSBs prices would have a larger impact on consumption of households with 'thin' individuals. We also find that the reform of the EU sugar policy might lead to a decrease in regular SSBs prices by 5% in average and to an increase of their market shares by 8%. This would imply an increase in the regular soft drink consumption of 1.3 liter per person and per year. Depending on the 'weight status' of the household, the average increase in per person consumption varies from 0.7 to 2.2 liters. Moreover, a tax depending on the sugar content of the soft drink (tax of 3 cents on products that contain between 30 and 80 grams of sugar per liter and of 6 cents if products exceed 80 grams) would more than counterbalance the impact of the sugar reform. Thus the average consumption would decrease by about 1.9 liter per person and per year. As for the impact of the sugar policy reform, the effect of the tax depends on the 'weight status' of the household.

The paper is organized as follows. Section 2 presents the main characteristics of the soft drinks industry. Section 3 presents the data and descriptive statistics about soft drink consumption. Section 4 describes the model and methods which are used to analyse the demand and to infer the more likely vertical relationships between manufacturers and retailers. In section 5 we discuss demand and supply results, cost estimates. In section 6 we discuss the results of policy simulations and we finally conclude in section 7.

2 The Soft Drinks market

In 2004, the turnover of the French soft drinks industry reaches 2.2 billion euros, that is 1.6% of the total turnover of the French food industry. Soft drinks represent about 11% of the total beverages consumption in France which include mineral water, alcohol, coffee, tea, drinking milk as well as fruit juices (*Canadean, 2004*). In average, soft drinks consumption increased by 32% from 1994 to 2004.[5] Nevertheless, the per capita consumption in France (42.5 liters per year) remains small as compared to the per capita consumption in the EU (71.2 liters in average). Market analysts frequently distinguish 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 concerned by the change in sugar price.[6] In our analysis, they are included in the 'outside' option for consumers as they are substitute of soft drinks.

In general, there are two versions of each soft drink: a regular one which is sweetened using caloric sweeteners, mainly 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.

The industry is highly concentrated with the first four manufacturers (Coca Cola Enterprises, Schweppes, Unilever and Pepsico) sharing 88.6% of the total production in 2004. Each of these manufacturers owns a brand portfolio even if Coca Cola and Pepsico are mainly involved in colas products and Unilever in iced tea.

3 Data

We use data from a consumer panel data collected by TNS WordPanel. We have a french representative survey of 19,000 households over a three years period (2003-2005). This survey provides information on

[5] Note that consumption of diet drinks increased by 224% from 1994 to 2004.
[6] Fruit juices do not contain added sugar while nectar contains less than 6% of added sugar.

purchases of food products (quantity, price, brand, characteristics of goods, store) and on characteristics of households (income, number of children and adults, weight and heigh of each person, ...).

From the panel data, we select 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. Taking into account the set of products distributed by each retailer we get 105 (or 104 depending on the period) differentiated products which compete on the market.[7] We provide in Table 1 some descriptive statistics on price and market shares.

		Prices (in euros per liter) Mean (std)	Market Shares 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 1: General Descriptive Statistics for Prices and Market Shares

Market shares are defined as follows. We first consider the total market of SSB including soft drinks, fruit juice and nectar. This is considered as the relevant market. Market shares 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 and 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) as well as purchases of other soft drinks (77 brands with very low market share for a total of 11% of the market) or purchases of the considered soft drinks in non considered retailers (66 other retailers as well as other distribution channels for a total of 16% of the market).

We now focus on the brands and retailers selected in our analysis. As shown on Table 1, they represents 33.8% of the whole market. The average price over all products and all periods is 0.82 euros per liter.

[7] From the consumer perspective, a product is the combination of a brand and a retailer.

Regular products dominates as they represent about 80% of soft drinks purchases; their prices is 15% lower than prices of diet products. PLs hold about 27% of the market of soft drinks and are sold at about half of the price of NBs.

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We provide some additional information on the soft drinks market (that is excluding the 'outside good') in Annex (Tables 8 and 9). Brands 1 to 11 are NBs while brands 12 to 14 are PLs. The main NB has a market share larger than 30% while the smallest one has less than 1% of the market (table 8). The market share of private label products vary between 6 and 12% for the three categories of products considered. Average NBs prices vary from 0.74 to 1.12 /l while PL prices range from 0.38 to 0.54 /l. Market shares of retailers are also heterogenous and vary from 2% to 20% (table 9). In average, prices in the different retailers are similar except for retailers 8 and 9 which sell at significant lower prices because a large share of their sales comes from private labels.[8]

Percentage of overweight and obese people	Number of Households	Consumption Mean	Consumption Std
No	9569	16.5	11.6
less than half	8234	16.3	8.8
More than half	4216	18.4	12.0
All	782	19.1	11.5
Whole sample	22801	16.9	10.7

Table 2: Consumption of soft drinks: Descriptive Statistics

Given the definition of the market, the average consumption of soft drinks per year and per person in our sample is 16.9 liters. There is, in average, some increase in the consumptin of soft drinks when the percentage of overweight and obese people increase. However given the large variations across households, there is no significant differences among the different categories of households.

[8]The average price of a brand for a period is calculated as the weighted average of the price over the different retailers. Similarly, the average price of a retailer is calculated as the weighted average of the price over the different products he sells.

4 Models and methods

To analyze the impact of a decrease of an input price, we follow the general methodology recently developped to analyse vertical relationships between manufacturers and retailers (e.g. Berto Villas-Boas, 2007; Bonnet and Dubois, 2010). We consider a demand model to get price elasticities of demand for every product. The model needs to be as flexible as possible and we thus opt for a random coefficients logit model (Berry et al., 1995; McFadden and Train, 2000). As the pass-through of a change in input prices in the channel can be modified by the nature of contracts between firms of the sector or by vertical restraints considered we design, as suggested by Bonnet, Dubois and Villas Boas (2009), alternative models of vertical relationships between processors and retailers. From the first order conditions and estimates of demand, we are able to calculate price cost margins for manufacturers and retailers from which we deduce cost estimates. To choose the model of vertical relationship that best fits the data, we estimate a cost model where calculated cost from the vertical relationships models is the endogenous variable. To choose among the different models, we use a non nested Rivers and Vuong (2002) test. Finally, using the estimated 'best' model, we simulate the impact of a change in sugar price on consumers prices and then on consumption. We also evaluate the impact of alternative tax policies that are proposed to limit the decline in prices of SSBs. In the following, we provide a brief summary about the main assumptions and methods. The reader will find much more explanations in Bonnet and Dubois (2010) about the details of the methods.

4.1 The Demand Model: a random coefficients logit model

We use a random coefficients logit model to estimate the demand model and elasticities. The indirect utility funtion V_{ijt} for the consumer i buying the product j at period t is given by

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

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

We assume that α_i, ρ_i and the τ_{ik} vary across consumers. Indeed, consumers may have a different price disutility or different tastes for the diet characteristic or for the categories of products considered. We assume that their distributions are independent and that the 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 2x1 vector which captures the unobserved consumers characteristics. Π is a $2 \times d$ matrix of coefficients that measure the taste characteristics through demographics and Σ is a 2×2 diagonal matrix of parameters $(\sigma_\alpha, \sigma_\rho)$ that measure the unobserved heterogeneity of consumers. We suppose that $P_v(.)$ is a parametric distribution of v_i, $P_D(.)$ 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 in a mean utility $\delta_{jt} = \beta_j + \gamma_t + \alpha p_{jt} + \rho l_j + \xi_{jt}$ and a deviation to this mean utility $\mu_{ijt} = [p_{jt}, l_j] \left(\sigma_\alpha v_i^{\alpha} + \pi_\alpha D_i, \sigma_\rho v_i^{\rho} + \pi_\rho D_i\right)'$. 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 ε_{ijt} is independently and identically distributed like an extreme value type I distribution, we are able to write the market share of product j at period t in the following way (Nevo, 2001) :

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

where A_{jt} is the set of consumers who have the highest utility for product j at period t, a consumer is defined by the vector $(D_i, \nu_i, \varepsilon_{i0t}, ..., \varepsilon_{iJt})$. We assume that the distribution P_ν is independently and normally distributed with respectively a mean α and ρ and a standard deviation σ_α and σ_ρ.

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

$$\frac{\partial s_{jt}}{\partial p_{kt}} \frac{p_{kt}}{s_{jt}} = \begin{cases} -\frac{p_{jt}}{s_{jt}} \int \alpha_i s_{ijt}(1 - s_{ijt}) \ \phi(v_i) dv_i & \text{if } j = k \\ \frac{p_{kt}}{s_{jt}} \int \alpha_i s_{ijt} s_{ikt} \ \phi(v_i) dv_i & \text{otherwise.} \end{cases} \tag{2}$$

4.2 Supply models: vertical relationships between processors and retailers

The economic literature has extensively explored vertical relationships between manufacturers and retailers (e.g. Rey and Vergé, 2004). In food retailing, upstream and downstream sector are highly concentrated and it is well known that with chain of oligopolies linear contracts are not efficient as the profit of the chain is not maximised. Indeed, this give incentives to agents to design more sophisticated contracts such as non linear contracts and particularly two-part tariffs contracts. In the empirical literature, it is only recently that two-part tariffs were integrated in the analysis (Berto villas Boas, 2007; Bonnet and Dubois, 2010). We consider both linear pricing, characterized by Bertrand-Nash competition at downstream and upstream levels, and two part-tariffs contracts where processors have all bargaining power.[9]

The general framework of vertical relationships between manufacturers and retailers is described by the following game:

- stage 1: Manufacturers propose simultaneously take-it or leave-it contracts to retailers; depending on the supply model, we define only the wholesale price if we assume linear contract , or both a fixed fee and wholesale price in the case of two part tariffs, and finally we specify consumer price in addition to the fixed fee and wholesale price for two-part tariffs with resale price maintenance;

- stage 2: Retailers simultaneously accept or reject the offers which are public information. If a retailer rejects one offer, he gets his outside option which is either positive fixed value if private

[9] This primarily affects how profits are sharing (through the fixed fees) rather than the choices of prices which is what is studying here. According to Rey and Vergé (2004), equilibrium prices would be the same if retailers have all bargaining power. We will also justify this assumption when analysing the results from the demand analysis.

labels are not acknoledged (as in Bonnet and Dubois, 2010) or the profit coming from private labels otherwise;

- stage 3: Retailers set consumer prices.

In the following, we briefly present the general methodology (for an extensive presentation of the methodology, the reader should refer to Bonnet and Dubois, 2010). The profit of retailer r is given by:

$$\Pi^r = \sum_{j \in S_r} [M(p_j - w_j - c_j)s_j(p) - F_j]$$

where M is the size of the market, S_r the set of products that the retailer r sells, w_j and p_j the wholesale and retail prices of product j, $s_j(p)$ the market share of product j and c_j the constant marginal cost of distribution of product j. In the specific case of private labels, we assume that they are sold to retailers at marginal cost by the producing firms.[10]

Assuming price competition among retailers and assuming the existence of the equilibrium, the first-order conditions are given by:

$$s_j + \sum_{k \in S_r} [(p_k - w_k - c_k)] \frac{\partial s_k}{\partial p_j} = 0 \quad \forall j \in S_r, \qquad \text{for } r = 1, ..., R \tag{3}$$

These are standard conditions defining the Bertrand-Nash equilibrium of the third stage of the game. Obviously, these conditions are valid whatever manufacturers propose linear prices or two-part tariffs (but only when resale price maintenance is not allowed).[11]

In the following we focus more on two-part tariffs, as the linear case (double marginalisation) is now well known (refer to Sudhir, 2001; Berto Villas-Boas, 2007 and Bonnet and Dubois 2010). Let define μ_j the constant marginal cost of production of product j and G_f the set of products sold by the manufacturer f. The manufacturer maximizes its profit

$$\Pi^f = \sum_{j \in G_f} [M(w_j - \mu_j)s_j(p) + F_j]$$

[10] A retailer defines the characteristics of his own private label. Then, he delegates the production of this product to a manufacturer. In this process, he organizes competition among producers for a given product. This is interpreted as a price competition with homogenous product leading to a selling price equal to marginal costs. For additional information on private labels, refer to Bergès-Sennou et al. (2004).

[11] With resale price maintenance, it is manufacturers who determine consumer prices of national brands. Retailers do not have any strategic role in determining prices of national brands. They only have a strategic role in setting prices of private labels. Then, the FOC defined only apply for the subset of private labels retailer r distributes.

subject to the participation constraints of each retailer, i.e. for all $r = 1,..,R$, $\Pi^r \geq \sum_{j\in\widetilde{S}_r} M(\widetilde{p}^r_j - w_j - c_j)s_j(\widetilde{p}^r)$ where $\widetilde{S}_r$ is the set of private labels belonging to retailer r and $\widetilde{p}^r = (\widetilde{p}^r_1, ..., \widetilde{p}^r_J)$ is the vector of prices in the case where the retailer r sells only its private labels. By convention, we have $\widetilde{p}^r_j = +\infty$ for all brands sold by the retailer r except for private labels. The vector of market shares $s(\widetilde{p}^r)$ thus corresponds to market shares when the retailer r sold only its private labels.

Manufacturers can adjust franchise fees such that all constraints are binding. Using the participation constraint of retailer r allows to re-write the profit of manufacturer f as (see details in Appendix 1):

$$\Pi^f = \sum_{j\in G_f} M(w_j - \mu_j)s_j(p) + \sum_{j=1}^{J} M(p_j - w_j - c_j)s_j(p) - \sum_{r=1}^{R}\sum_{j\in\widetilde{S}_r} M(\widetilde{p}^r_j - w_j - c_j)s_j(\widetilde{p}^r) - \sum_{j\notin G_f} F_j$$

Thus the profit of a manufacturer is no longer a function of the fixed fees attached to his own products. Rather his profit depends on the fixed fees set by the other manufacturers. Thus, the maximisation problem is more simple to solve and everything happens as if the manufacturer chooses either wholesale prices when there is no resale price maintenance (as in the linear case) or consumer prices when there is resale price maintenance.

We consider first the case where manufacturers can use resale price maintenance in their contracts with retailers. In this case, manufacturers propose to retailers the franchise fees F as well as the retail prices p. Note that wholesale prices have no direct effect on profits[12]. Therefore, the program of the manufacturer f is given by

$$\max_{\{p_k\}_{k\in G_f}} \sum_{j\in G_f} M(w_j - \mu_j)s_j(p) + \sum_{j=1}^{J} M(p_j - w_j - c_j)s_j(p) - \sum_{r=1}^{R}\sum_{j\in\widetilde{S}_r} M(\widetilde{p}^r_j - w_j - c_j)s_j(\widetilde{p}^r).$$

We deduce the first order conditions for this manufacturer's program

$$\sum_{j\in G_f}(w_j-\mu_j)\frac{\partial s_j(p)}{\partial p_k}+s_k(p)+\sum_{j=1}^{J}(p_j-w_j-c_j)\frac{\partial s_j(p)}{\partial p_k}-\sum_{r=1}^{R}\sum_{j\in\widetilde{S}_r}(\widetilde{p}^r_j-w_j-c_j)\frac{\partial s_j(\widetilde{p}^r)}{\partial p_k} = 0 \quad \forall j \in G_f, \quad \text{for } f = 1,...,N_f \tag{4}$$

The above conditions only apply for NBs. For PLs, retailers maximize their profit with respect to the

[12] Wholesale prices of the manufacturer f have no direct effect on profit but they have a strategic role in the retail price choices because they affect profits of the other manufacturers.

retail prices of PLs:

$$\max_{\{p_k\}_{k\in\widetilde{S}_r}} \sum_{j\in\widetilde{S}_r}(p_j-\mu_j-c_j)s_j(p)+\sum_{j\in S_r\setminus\widetilde{S}_r}(p_j^*-w_j-c_j)s_j(p^*)$$

with p_j^* stands for the price of NBs choosen by manufacturers. Thus, for PLs, additional equations are obtained from the first order conditions of the profit maximization of retailers which both produce and retail these products:

$$\sum_{j\in\widetilde{S}_r}(p_j-\mu_j-c_j)\frac{\partial s_j(p)}{\partial p_k}+s_k(p)+\sum_{j\in S_r\setminus\widetilde{S}_r}(p_j^*-w_j-c_j)\frac{\partial s_j(p^*)}{\partial p_k}=0 \quad \forall j\in\widetilde{S}_r, \quad \text{for } r=1,...,R \quad (5)$$

Basically, the system of equations 4 and 5 characterises the equilibrium which depends on the structure of the industry at the manufacturer and retailer levels and the demand shape. It should be noted that, because wholesale and retail margins cannot be identified in this system, it is needed to have additional assumptions on the margins. As in Bonnet and Dubois (2010), we assume either zero wholesale margins for national brands ($w_j-\mu_j=0$) or alternatively zero retail margins for national brands ($p_j-w_j-c_j=0$).

In the case where resale price maintenance is not allowed, manufacturer f maximizes its profit with respect to wholesale prices:

$$\max_{\{w_k\}_{k\in G_f}} \sum_{j\in G_f} M(w_j-\mu_j)s_j(p)+\sum_{j=1}^{J}M(p_j-w_j-c_j)s_j(p)-\sum_{r=1}^{R}\sum_{j\in\widetilde{S}_r}M(\widetilde{p}_j^r-w_j-c_j)s_j(\widetilde{p}^r).$$

From which we deduce the first order conditions $\forall j\in G_f$, for $f=1,...,N_f$:

$$\sum_{j\in G_f}(w_j-\mu_j)\frac{\partial s_j(p)}{\partial w_k}+\sum_{j=1}^{J}\frac{\partial p_j}{\partial w_k}s_j(p)+\sum_{j=1}^{J}(p_j-w_j-c_j)\frac{\partial s_j(p)}{\partial w_k}-\sum_{r=1}^{R}\sum_{j\in\widetilde{S}_r}M(\widetilde{p}_j^r-w_j-c_j)\frac{\partial s_k(\widetilde{p}^r)}{\partial w_k}=0 \quad (6)$$

The equilibrium is then characterised by the system of equations 6 where the retail prices response matrix to wholesale prices containing the first derivative of retail prices with respect to wholesale prices is obtained by totally differentiating 3 and the retail margins are deduced from 3.

To sum up, we consider 7 different models: double marginalization (as in Berto Villas- Boas, 2007), two part tariffs with or without resale price maintenance ignoring the role of PLs (as in Bonnet and Dubois, 2010) and two part tariffs with or without resale price considering the role of PLs.[13]

[13] Note that we consider two versions of contracts with resale pricemaintenance: either zero wholesale margins for national brands ($w_j-\mu_j=0$) or alternatively zero retail margins for national brands ($p_j-w_j-c_j=0$).

4.3 Cost specification and testing between alternative models

Once the demand model is estimated and given the assumptions on the structure of the industry and the vertical interactions, price-cost margins are estimated. We thus obtain estimated costs $C_{jt}^h = p_{jt} - \Gamma_{jt}^h - \gamma_{jt}^h$ for each product j at period t in any supply model h considered, where $\Gamma_{jt}^h = w_{jt}^h - \mu_{jt}^h$ is the margin of manufacturer on product j and $\gamma_{jt}^h = p_{jt}^h - w_{jt}^h - c_{jt}^h$ is the margin of retailer on product j.

We specify a fixed effects model for the marginal cost estimated and assume that it takes the following specification:

$$\ln C_{jt}^h = w_{jt}^h + \sum_{k=1}^{K} \left(\lambda_k^h\right)^2 \ln W_{jt}^k + \sum_{k=1}^{K} \pi_k^h \left(\ln W_{jt}^k\right)^2 + \tau_t^h + \eta_{jt}^h$$

where w_{jt}^h represents product fixed effects of product j for model h, τ_t^h are time fixed effects and W_{jt} is a vector of inputs. We suppose that $E(\eta_{jt}^h | W_{jt}', w_{jt}^h, \tau_t^h) = 0$ in order to identify and estimate consistently w_{jt}^h, τ_t^h, λ_k^h and π_k^h.

We use this cost function specification to test two different supply models C_{jt}^h and $C_{jt}^{h'}$ and infer which model is statistically the best using non nested Rivers and Vuong (2002) test. To impose the positivity of parameters in order to be consistent with the economic theory (Gasmi, Laffont and Vuong, 1992) and to allow this two-degree polynomial of input variables, we use a non linear least square method to estimate parameters.

4.4 Simulations

Given the marginal costs estimated from the preferred pricing equilibrium and using the other estimated structural parameters, one can simulate the policy experiments of interest (sugar price decrease and sugar content tax). We denote $C_t = (C_{1t}, .., C_{jt}, .., C_{Jt})$ the vector of these marginal costs for all products present at time t, where C_{jt} is given by $C_{jt} = p_{jt} - \Gamma_{jt} - \gamma_{jt}$. To model the impact of a change in sugar price, we have to solve the following program:

$$\min_{\{p_{jt}^*\}_{j=1,..,J}} \left\| p_t^* - \Gamma_t\left(p_t^*\right) - \gamma_t\left(p_t^*\right) - \widetilde{C}_t \right\|$$

where $\|.\|$ is the euclidean norm in $\mathbb{R}^J$, γ_t and Γ_t correspond respectively to the expression of the retail and wholesale margins of the best supply model and $\widetilde{C}_t$ is the vector of marginal cost estimated with the new sugar price. A taxation of SSBs according to their sugar content is interpreted as adding a constant (which depends on the sugar content of each product) to the marginal cost of the product. Then, modelling the impact of a tax in addition to the sugar policy reform is obtained by adding the relevant constant values to $\widetilde{C}_t$.

5 Results

In this section, we present and discuss demand results, price-cost margins as well as the results of policy simulations.

5.1 Demand results

We estimate the random coefficients logit model using the well-known GMM method proposed by Berry, Levinson and Pakes (1995) and Nevo (2000, 2001). This method requires the use of a set of instruments to solve the endogeneity problem of prices. We use input price indexes of wages, plastic, aluminium, water, sugar and gazole.[14] Thus, it is unlikely that input prices are correlated with unobserved demand determinants. These variables are interacted with dummies representing national and store brands because we expect that the large manufacturers obtain from their suppliers lower prices than the producers of private labels get.[15] We also expect that the cost of bottles and cans differ due to 'quality' differences.

Table 3 shows results of the demand model estimates by GMM accounting for consumer heterogeneity in the sensitivity of price and the taste of observed product characteristics.[16] First, note that the overidentifying restriction test is not rejected which means 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 which means that these households are less price sensitive. The coefficient of the dummy identifying diet products is positive on average meaning that

[14] These indexes are from the French National Institute for Statistics and Economic Studies.

[15] Indeed, firms as Coca Cola Inc have always refused to produce private labels that compete with their own brands.

[16] This estimation was realized with 500 draws for the parametric distribution representing the unobserved consumer characteristics and the nonparametric distribution of consumer demographics.

consumers like this characteristic. However, the proportion of overweight and obese individuals in a household impacts negatively the coefficient of the diet characteristic.This means that the preference for diet products decrease with the proportion of overweight and obese individuals in households.

Coefficients (Std. error)	Mean	Standard Deviation
Price	-8.31 (1.04)	0.37 (0.78)
Proportion of overweight and obese people	8.56 (1.84)	
Diet	4.33 (0.08)	
Proportion of overweight and obese people	-7.02 (5.85)	
Coefficients δ_j, γ_t not shown		
Overidentifying Restriction Test (df)	9.40 (9)	

Table 3: Results for the random coefficients logit model

From the structural demand estimates, we are able to compute own and cross-price elasticities for each differentiated products (Table 4).[17] Own-price elasticities of demand for a brand vary between -3.0 and -9.4 and is -4.4 on average. A key result is that demand for regular products is 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 -3.5 while it is about -8.7 for diet brands. Thus even if in average consumers have some preference for diet products their demand is much more price sensitive. Same magnitude of own price elasticities are obtained by other studies on the soft drink markets 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 in the analysis the higher the elasticity of a single brand. Thus, Gasmi, Laffont and Vuong (1992) estimate own price elasticities to -2 for Coca-Cola and Pepsi-Cola. For the Carbonated Soft Drink US market, Dhar, Chavas, Cotteril and Gould (2005) distinguished 4 brands and found own-price elasticities between -2 and -4. On the same market, but using a higher level of disagregation (about 20 brands), Dubé (2005) found elasticities ranging from -3 to -6[18].

[17] 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.

[18] Unfortunately, according to our knowledge, there is no other study on the French soft drink market.

The analysis of cross-price elasticities among products in a given retailer reveals that all products are substitute as all cross-price elasticities are positive. Substitutions are mainly among products with similar sugar profile. That is regular products (that is sweetened with caloric sweeteners) substitute with other regular products rather than with a diet product. Conversely, diet products substitute more with the 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[19].

Finally, thanks to (2), 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 -9.1 to -2.2 when the proportion of overweight and obese individuals in the household increases. Then, household with overweight and obese people will react much less to a change in the price of brand. The decrease of 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 drink by household without overweight and obese people than by household with overweight and obese people.

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14
B1	-3.8671	0.0068	0.0081	0.0045	0.0077	0.0055	0.0078	0.0075	0.0053	0.0080	0.0080	0.0127	0.0123	0.0123
B2	0.0082	-7.4623	0.0030	0.0209	0.0015	0.0180	0.0019	0.0011	0.0191	0.0031	0.0027	0.0219	0.0159	0.0162
B3	0.2364	0.0626	-3.5652	0.0849	0.2592	0.1163	0.2579	0.2604	0.1039	0.2498	0.2536	0.1595	0.1967	0.1863
B4	0.0181	0.0594	0.0117	-8.8259	0.0067	0.0507	0.0078	0.0053	0.0527	0.0123	0.0108	0.0445	0.0292	0.0311
B5	0.0051	0.0007	0.0057	0.0011	-3.7484	0.0017	0.0063	0.0065	0.0015	0.0057	0.0058	0.0026	0.0037	0.0033
B6	0.0001	0.0003	0.0001	0.0003	0.0001	-9.3625	0.0001	0.0000	0.0003	0.0001	0.0001	0.0003	0.0002	0.0002
B7	0.0046	0.0008	0.0052	0.0011	0.0057	0.0017	-3.7686	0.0058	0.0014	0.0052	0.0053	0.0025	0.0035	0.0031
B8	0.0048	0.0005	0.0056	0.0008	0.0063	0.0014	0.0062	-3.7626	0.0011	0.0055	0.0056	0.0022	0.0033	0.0029
B9	0.0004	0.0010	0.0003	0.0010	0.0002	0.0009	0.0002	0.0001	-9.3798	0.0003	0.0002	0.0008	0.0006	0.0006
B10	0.0050	0.0014	0.0053	0.0019	0.0053	0.0026	0.0054	0.0054	0.0023	-3.8278	0.0053	0.0036	0.0042	0.0040
B11	0.0029	0.0007	0.0031	0.0010	0.0032	0.0014	0.0032	0.0033	0.0012	0.0031	-3.8060	0.0019	0.0024	0.0022
B12	0.0326	0.0466	0.0122	0.0239	0.0084	0.0238	0.0093	0.0076	0.0240	0.0123	0.0117	-3.0248	0.0398	0.0403
B13	0.0046	0.0053	0.0026	0.0029	0.0021	0.0032	0.0022	0.0020	0.0031	0.0026	0.0025	0.0064	-3.6091	0.0058
B14	0.0091	0.0099	0.0058	0.0073	0.0046	0.0078	0.0048	0.0042	0.0077	0.0058	0.0056	0.0118	0.0106	-3.5454

Table 4: Own and Cross Price Elasticities between Brands within the same Retailer

[19] According to the 'taste', there are three products categories. The category 1 are composed by brands 1 to 4 and 12; category 2 by brands 5, 6 and 13; category 3 by brands 7 to11 and 14. According to sweeteners, there are two categories (regular, diet) with diet products being brands 2, 4, 6 and 9.

To investigate if consumers have strong preferences for brands we compare the following alternative for a consumer. If the price of a brand increases, does a consumer switch for an other brand sold by the same retailer or does he prefer to switch of retailer in order to buy this brand? As shown by Steiner (1993), if he prefers to switch of brand then the bargaining power is in favor of retailers and otherwise it is in favor of manufacturers. We report in Table 10 (see the annex) the average of cross-price elasticities of each brand computed within a retailer (switch of brand) and within the same brand (switch of retailers). Results suggest that consumers prefer to switch of retailer in order to buy their prefered brand rather than switching of brands within a given retailer. This is particularly true for the two leading brands (brands 3 and 4). This result suggest that manufacturers have market power on this sector and that is consistent with our main assumption on the non linear supply models which consists in giving all bargaining power to manufacturers.

5.2 Prefered model, price-cost margins and cost estimation

Thanks to demand estimates, we are able to compute price cost margins for each supply models. The Rivers and Vuong tests (see results in Table 12 in appendix) suggest that the best supply model is the one where manufacturers and retailers use two part tariffs contracts with resale price maintenance and the retail margin equal to zero and when the strategic role of private labels is not taken into account. According to the results, the price cost margins is about 32.77% of the consumer price in average. Across brands, these margins are relatively heterogeneous. We obtain that the price cost margins of brands 3 and brand 11 are significantly higher than those estimated for the other NBs. We also get that the average price cost margins for PLs (36.84%) are significantly different than the average price cost margins for NBs (31.42%). We also obtain that the price cost margins for diet brands (14.50%) are lower than for regular products (39.71%). Price cost margins do not differ across retailers except for the retailer 9 which exhibits higher margins. This could be the consequence of the strategy of retailer 9 which only sells private labels and brands 3 and 4 where brand 3 has the highest margin of all brands. Apparently, brand 3 is a very strong brand whose absence on the shelf might discourage some clients to come in the outlet. In other words, any retailer needs to distribute brand 3.

The estimated marginal cost deduced from the best supply model is 0.55 per liter on average. For private labels, we obtain a lower average marginal cost (0.30 per liter) than for national brands (0.63 per liter). According to the estimation of the marginal cost function (Table 11 in appendix), wages and plastic, aluminium, water, gazole and sugar prices explain significantly the estimated marginal cost.

6 Simulations

6.1 Impact of sugar policy reform

In line wih the anticipated impact of the reform of the EU sugar policy, we simulate a decrease by one third of the sugar price. In average, this represents a 5.22% decrease in the marginal cost of production of regular soft drinks. A decrease by one third of the sugar price then corresponds to a decrease of 2.45 cents of euros which are approximately one third of the accounting sugar cost. This decrease is approximately the same across brands (Table 5).[20] Simulations suggest that the average estimated price decreases by 5.53% for regular products. For regular products the pass-through, measured by the ratio of the difference in retail prices and the difference in marginal costs, is about 1.81. This pass-through is relatively high but consistent with figures that Campa and Golberg (2006) find for pass-through rates in food industry for France, i.e. 1.41[21]. Therefore, if the marginal cost decreases by 1 cent the retail price decreases on average by 1.8 cents. The pass-through is larger than 1 meaning that regular brands would act 'agressively' in order to significantly increase their market share, particularly the leading brand (Brand 3) which has a large pass-through (2.83). The price of diet products does not change (as their price increases or decreases by less than 0.2% that is about 0.2 Euro cents). Even if results are presented brand by brand it should be acknowledged that the model integrates the fact that a manufacturer has several brands and thus chooses its pricing policy for the whole set of products, internalising substitution

[20] Brands 2, 4, 6 and 9 are diet products.

[21] Campa and Golberg (2006) find lower values for Germany (0.48) or US (0.21) which was confirmed by structural analysis of Bonnet, Dubois and Villas Boas (2009) on the German coffee market where they estimate a pass-through of 0.8 or of Nakamura and Zerom (2010) in the US coffee market with an estimates of pass-through rates of 0.30.

among his own set of products. As a result of these strategic reactions, the aggregate market share of regular products increases by 7.6% which is explained by substitution with diet products (whose market share decreases by 4.1%) as well as with the outside option (whose market share decreases by 3%).[22]

	Change in cost in % Mean (std)	Change in price in % Mean (std)	Pass-through $\triangle p/\triangle c$ Mean (std)	Change in MS in % Mean (std)
Brand 1	-5.01 (0.02)	-5.58 (0.37)	1.75 (0.17)	7.65 (1.64)
Brand 2	–	0.06 (0.03)	-	-3.10 (0.55)
Brand 3	-5.06 (0.02)	-6.71 (0.77)	2.83 (0.51)	11.19 (2.39)
Brand 4	–	0.21 (0.05)	-	-5.52 (0.97)
Brand 5	-5.50 (0.08)	-5.16 (0.36)	1.43 (0.10)	5.75 (1.82)
Brand 6	–	-0.12 (0.12)	-	-4.10 (0.94)
Brand 7	-5.26 (0.02)	-5.19 (0.55)	1.59 (0.17)	5.93 (2.32)
Brand 8	-5.07 (0.02)	-4.66 (0.40)	1.45 (0.12)	4.32 (1.69)
Brand 9	–	-0.06 (0.05)	-	-4.06 (0.85)
Brand 10	-5.23 (0.02)	-5.91 (0.48)	1.87 (0.17)	8.36 (2.26)
Brand 11	-5.11 (0.02)	-6.43 (0.95)	2.65 (0.51)	10.38 (3.40)
Brand 12	-5.21 (0.24)	-4.69 (0.66)	1.49 (0.11)	6.00 (2.37)
Brand 13	-5.46 (0.05)	-5.66 (0.64)	1.61 (0.15)	8.90 (2.13)
Brand 14	-5.27 (0.08)	-5.40 (0.49)	1.59 (0.15)	8.22 (1.51)

Table 5: Simulation of a decrease by one third decrease of the sugar price

6.2 Impact of a tax on SSBs

In order to counterbalance the impact of the sugar policy reform, some representatives have proposed to set a tax on SSBs based on their sugar content. Thus they proposed to set a tax which amounts to 3 cents per liter if the sugar content of the soft drink is between 30 and 80 grams and to 6 cents per liter if the sugar content is higher than 80 grams. We interpret this tax as an additional increase in the total marginal cost. In Table 5, we compare the impact of the sugar policy reform alone (denoted policy 1) with the impact of the combination of the sugar policy reform and the tax policy (denoted policy 2). The second and fifth columns provide respectively initial prices and market shares for each brand. The third and sixth columns provide prices and market shares in policy (1) and the fourth and seventh columns give the same information for policy (2). Results suggest that the tax would more than annihilate the effect of the decrease in sugar price. Thus, prices of regular products are higher than initial prices (except

[22] 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.

for brand 5 which is taxed at 3 cents/liter rather than 6 cents/liter due to its small sugar content). Even if the level of the tax is roughly equal to the decrease in the price of soft drinks under policy 1, the strategic action of manufacturers (remind that the model of vertical relationshipsbetween manufacturers and retailers includes rpm) explain why with policy 2, the price of the soft drinks increases as compared to the initial situation.

As a consequence of pricing strategies, the market shares of regular products decrease (by 7.5%) while the market share of diet products increase by 7.3% and the market share of the outside option increases by 4.39% with policy 2 which thus more than counterbalance the impact of the decrease in sugar price [23].

	Price			Market shares		
	Initial	Policy 1	Policy 2	Initial	Policy 1	Policy 2
	Mean (std)	Mean (std)	Mean (std)	Mean (std)	Mean (std)	Mean (std)
Brand 1	0.74 (0.11)	0.69 (0.10)	0.79 (0.10)	0.84 (0.14)	0.91 (0.15)	0.73 (0.12)
Brand 2	0.72 (0.08)	0.72 (0.08)	0.72 (0.08)	1.05 (0.19)	1.01 (0.19)	1.11 (0.20)
Brand 3	0.87 (0.04)	0.82 (0.04)	0.95 (0.04)	11.07 (0.78)	12.33 (0.93)	9.75 (0.59)
Brand 4	0.91 (0.05)	0.91 (0.05)	0.90 (0.05)	4.37 (0.28)	4.13 (0.27)	4.76 (0.30)
Brand 5	1.04 (0.08)	0.98 (0.07)	1.03 (0.07)	1.30 (0.45)	1.37 (0.49)	1.49 (0.50)
Brand 6	1.05 (0.14)	1.05 (0.14)	1.05 (0.14)	0.24 (0.08)	0.23 (0.07)	0.25 (0.08)
Brand 7	1.02 (0.11)	0.97 (.11)	1.06 (0.10)	1.27 (0.20)	1.35 (0.23)	1.26 (0.19)
Brand 8	1.12 (0.08)	1.07 (0.08)	1.16 (0.07)	1.25 (0.30)	1.31 (0.33)	1.28 (0.29)
Brand 9	1.00 (0.07)	1.00 (0.07)	1.00 (0.07)	0.80 (0.21)	0.77 (0.20)	0.86 (0.23)
Brand 10	0.86 (0.07)	0.81 (0.06)	0.91 (0.06)	1.47 (0.23)	1.60 (0.26)	1.37 (0.19)
Brand 11	0.90 (0.07)	0.85 (0.08)	0.97 (0.07)	0.84 (0.14)	0.93 (0.17)	0.75 (0.11)
Brand 12	0.37 (0.08)	0.36 (0.08)	0.43 (0.08)	3.05 (0.20)	3.18 (0.89)	2.13 (0.14)
Brand 13	0.53 (0.13)	0.50 (0.12)	0.56 (0.13)	1.96 (0.43)	2.10 (0.46)	1.84 (0.39)
Brand 14	0.49 (0.09)	0.46 (0.08)	0.55 (0.09)	4.02 (0.44)	4.31 (0.48)	3.02 (0.31)

Table 6: Simulations of Policy 1 and Policy 2.

6.2.1 Impact on households

Thanks to the demand estimate which takes into account different price sensitivity 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 7 provides the impact of both policies on the average consumption of regular and diet products for 3 groups of households: households with no overweight and obese individuals,

[23] Market shares reported on Table 7 take into account the outside option. This explains why they are approximately 1/3 of those reported in Table 2 which were computed only on the considered market (which was about 1/3 of the total market).

households with less than half of overweight and obese individuals and households with more than half of overweight and obese individuals.

Under Policy 1, the average consumption of regular products increases by 1.3 liters while the average consumption of diet products remains roughly identical. Thus, the decrease in sugar price would sligthly raise the consumption of sugar products. However, these effects could be greater for households with a high number of overweight and obese individuals. For households where less than half of their members are overweight and obese, the increase is about 2.2 liters of regular soft drinks. On the contrary, with policy 2, the average consumption of regular products might decrease significantly (1.9 liters) while it increases slightly for diet products. As for policy 1, it is households where less than half of their members are overweight and obese which change the most their consumption.

Percentage of overweight and obese households	Proportion of households (%)	Regular Products		Diet Products	
		Policy 1 Mean (std)	Policy 2 Mean (std)	Policy 1 Mean (std)	Policy 2 Mean (std)
No	44	0.66 (0.12)	-1.15 (0.01)	-0.11 (0.01)	0.23 (0.01)
less than half	35	2.19 (0.42)	-3.06 (0.22)	-0.26 (0.05)	0.41 (0.03)
More than half	21	1.20 (0.04)	-1.62 (0.23)	-0.16 (0.01)	0.22 (0.02)
Total Population	100	1.30 (0.19)	-1.90 (0.07)	-0.17 (0.02)	0.29 (0.01)

Table 7: Change in soft drinks consumption for different groups of households (liter/person/year)

It should be noted that if we do not't take into account the vertical relationships in the soft Drink Industry, the impact on consumption is lower (see results in Table 13 in annex). Indeed, assuming a full transmission of the cost change, as it would be the case under perfect competition, the impact of Policy 1 would be half and the impact of policy 2 would be 1/3 lower as compared to the results we obtain integrating the strategic pricing of products.

7 Conclusion

The reform of the EU sugar policy reform will induce a significant decrease in the price of sugar. This reform is at odds of what is recommended by health authorities which argue that the consumption of added sugar should decrease in order to combat obesity. Sugar is mainly used by the food industry. In order to anticipate the impact of the sugar policy reform we have focused our analysis on a specific sector, the soft drink industry. Thus, soft drink consumption is frequently denonciated as a significant contributor to the obesity problem.

We argue that in order to analyse the impact of the sugar policy reform on the consumption of added sugar in food it is needed to take into account the pricing strategies of both manufacturers and retailers. Thus, using the recent development of empirical industrial organization, we have estimated a model of the vertical structure of the industry. We have shown that the most likely model of vertical relationships is the one where manufacturers and retailers use two part tariffs contracts with resale price maintenance while the strategic role of private labels is not taken into account. Using this model, we are able to simulate the impact on prices of alternative policy scenarios taking into account the strategic choice of agents. We have shown that the pass-through was in average larger than 1 meaning that the industry would transmit to consumers more than the decrease in cost. From these price changes, it is then possible to infer the change in the consumption of households. We have shown that these changes ranges from 1 to 2 liter/person/year which is a significant increase given the initial consumption. We have also shown that the proposed tax based on the sugar content of soft drink would more than annihilate the impact of the sugar policy reform. This suggests that taxing those goods might have a significant impact on the consumption. Our results also suggest that the impact of a sugar price decrease or a tax on sugar content on consumption would be significantly lower if vertical relationships are not taken into account.

Obviously, we have not estimated the impact of the sugar reform on the whole consumption of added sugar in the French population. Rather our work demonstrates that it is important to take into account the pricing strategy of the industry. As a consequence, it is needed to evaluate the impact for specific industries (relevant market) as there is no reasons that the results for the soft derink industry might be generalized to an onther industry (e.g. jam industry) as the structure of those industries is different.

8 Appendices

8.1 Descriptive statistics on data

	Prices (in euros per liter) Mean (std)	Market Shares Mean in % (std)
Brand 1	0.741 (0.112)	2.52 (0.43)
Brand 2	0.729 (0.081)	3.13 (0.64)
Brand 3	0.879 (0.049)	33.06 (2.72)
Brand 4	0.912 (0.053)	13.08 (0.96)
Brand 5	1.043 (0.081)	3.85 (1.21)
Brand 6	1.052 (0.143)	0.71 (0.22)
Brand 7	1.026 (0.114)	3.80 (0.52)
Brand 8	1.124 (0.084)	3.74 (0.81)
Brand 9	1.006 (0.070)	2.41 (0.60)
Brand 10	0.862 (0.071)	4.40 (0.69)
Brand 11	0.909 (0.079)	2.50 (0.36)
Brand 12	0.378 (0.089)	9.04 (0.66)
Brand 13	0.538 (0.131)	5.80 (1.14)
Brand 14	0.495 (0.094)	11.90 (1.13)

Table 8: Descriptive Statistics for Prices and Market Shares by Brands

	Prices (in euros per liter) Mean (std)	Market Shares Mean in % (std)
Retailer 1	0.831 (0.211)	13.32 (0.95)
Retailer 2	0.839 (0.238)	16.54 (1.12)
Retailer 3	0.856 (0.243)	8.14 (0.58)
Retailer 4	0.847 (0.224)	12.42 (0.97)
Retailer 5	0.817 (0.241)	20.49 (1.13)
Retailer 6	0.840 (0.226)	8.85 (0.80)
Retailer 7	0.903 (0.197)	5.21 (0.37)
Retailer 8	0.494 (0.057)	1.96 (0.30)
Retailer 9	0.424 (0.151)	13.02 (1.30)

Table 9: Descriptive Statistics for Prices and Market Shares by Retailers

8.2 Detailed proof of the manufacturers profit expression

Manufacturers can adjust franchise fees such that all constraints are binding. So the participation constraint for the retailer r becomes:

$$\sum_{j\in S_r}[M(p_j-w_j-c_j)s_j(p)-F_j]=\sum_{j\in\widetilde{S}_r}M(\widetilde{p}_j^r-w_j-c_j)s_j(\widetilde{p}^r)$$

$$\sum_{j\in S_r}F_j=\sum_{j\in S_r}M(p_j-w_j-c_j)s_j(p)-\sum_{j\in\widetilde{S}_r}M(\widetilde{p}_j^r-w_j-c_j)s_j(\widetilde{p}^r)$$

$$\sum_{j\in G_f}F_j+\sum_{j\notin G_f}F_j=\sum_{r=1}^{R}\sum_{j\in S_r}F_j=\sum_{j=1}^{J}M(p_j-w_j-c_j)s_j(p)-\sum_{r=1}^{R}\sum_{j\in\widetilde{S}_r}M(\widetilde{p}_j^r-w_j-c_j)s_j(\widetilde{p}^r)$$

$$\sum_{j \in G_f} F_j = \sum_{j=1}^{J} M(p_j - w_j - c_j)s_j(p) - \sum_{r=1}^{R} \sum_{j \in \widetilde{S}_r} M(\widetilde{p}_j^r - w_j - c_j)s_j(\widetilde{p}^r) - \sum_{j \notin G_f} F_j$$

Therefore, we can re-write the profit of the manufacturer as:

$$\Pi^f = \sum_{j \in G_f} M(w_j - \mu_j)s_j(p) + \sum_{j=1}^{J} M(p_j - w_j - c_j)s_j(p) - \sum_{r=1}^{R} \sum_{j \in \widetilde{S}_r} M(\widetilde{p}_j^r - w_j - c_j)s_j(\widetilde{p}^r) - \sum_{j \notin G_f} F_j \quad (7)$$

8.3 Price elasticities

Brands	Within a retailer	Between same brands
B1	0.011 (0.012)	0.012 (0.014)
B2	0.013 (0.016)	0.032 (0.032)
B3	0.185 (0.073)	0.251 (0.099)
B4	0.025 (0.016)	0.055 (0.035)
B5	0.003 (0.002)	0.006 (0.003)
B6	0.000 (0.000)	0.000 (0.000)
B7	0.003 (0.001)	0.005 (0.002)
B8	0.003 (0.001)	0.006 (0.003)
B9	0.000 (0.000)	0.000 (0.000)
B10	0.003 (0.002)	0.005 (0.002)
B11	0.002 (0.001)	0.003 (0.001)
B12	0.035 (0.052)	0.040 (0.052)
B13	0.005 (0.006)	0.005 (0.005)
B14	0.009 (0.008)	0.010 (0.008)

Table 10: Cross Price Elasticities between products

8.4 Cost function

Coefficients (Std. error)	$\ln \mathbf{C}_{jt}$
ln**Wages**	0.401 (0.002)
ln**Plastic**	0.978 (0.002)
ln**Aluminium**	0.902 (0.004)
ln**Water**	0.859 (0.004)
ln**Gazole**	0.754 (0.001)
ln**Sugar**	0.265 (0.000)
ln**Wages**^{2}	-0.772 (0.002)
ln**Plastic**^{2}	0.011 (0.000)
ln**Aluminium**^{2}	-0.156 (0.003)
ln**Water**^{2}	0.019 (0.000)
ln**Gazole**^{2}	0.001 (0.000)
ln**Sugar**^{2}	-0.015 (0.000)
Coefficients $w^h_{b(j)}, w^h_{r(j)}$ not shown	
F test for $w^h_{b(j)}$ (p value)	5844.53 (0.00)
F test for $w^h_{r(j)}$ (p value)	196.06 (0.00)

Table 11: Estimation of the marginal cost function

8.5 Non-nested tests

Rivers and Vuong Test Statistic T_n						
╲ H_2						
H_1	2	3	4	5	**6**	7
1	-2.83	-10.36	13.57	-6.16	**-11.11**	12.35
2		-12.71	9.51	-8.28	**-13.73**	8.34
3			15.11	15.02	**-19.41**	13.62
4				-12.25	**-15.56**	6.29
5					**-17.90**	10.67
6						**14.01**

Table 12: Non-nested tests of Rivers and Vuong (2002)

8.6 Simulations without accounting for vertical relationships

Percentage of overweight and obese households	Proportion of households (%)	Regular Products Policy 1 Mean (std)	Regular Products Policy 2 Mean (std)	Diet Products Policy 1 Mean (std)	Diet Products Policy 2 Mean (std)
No	44	0.36 (0.08)	-0.91 (0.11)	-0.03 (0.01)	0.07 (0.01)
less than half	35	1.06 (0.27)	-2.13 (0.20)	-0.10 (0.03)	0.21 (0.02)
More than half	21	0.56 (0.06)	-0.93 (0.13)	-0.07 (0.01)	0.11 (0.01)
Total Population	100	0.64 (0.14)	-1.32 (0.09)	-0.06 (0.01)	0.13 (0.01)

Table 13: Change in soft drinks consumption for different groups of households (liter/person/year)

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