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Strategic pricing and health price policies

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Strategic pricing and health price policies.

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Abstract

Healthier food diet is likely to prevent numerous non communicable diseases. Then there is a growing interest in evaluating the impact of food price taxation on food consumption. However, strategic reactions of both manufacturers and retailers are missing in empirical analysis. Rather, passive pricing is assumed. We develop a structural econometric model, to analyze vertical relationships between the food industry and the retail industry. We apply this model to the beverage industry and consider taxation of sugar. After selecting the 'best' model of vertical relationships, we simulate different taxation scenarios. We consider excise tax as well as ad valorem tax. We find that firms behave differently when facing an ad valorem tax or an excise tax. Excise tax is overshifted to consumer prices while ad valorem tax is undershifted to consumer prices. We find that an excise tax based on sugar content is the most efficient at reducing soft drink consumption. Our results also indicate that ignoring strategic pricing by firms leads to misestimate the impact of taxation by 15% to 40% depending on the products and the tax implemented.

JEL codes:H32, L13, Q18, I18

Key words: excise tax, ad valorem tax, vertical contracts,strategic pricing, differentiated products, soft drinks.

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1 Introduction

According to the World Health Organization, non communicable diseases, mainly cardiovascular diseases, cancers, chronic respiratory diseases and diabetes cause about 35 million deaths each year representing about 60% of all deaths.[1] Moreover up to 80% of heart disease, stroke, and type 2 diabetes and over a third of cancers could be prevented by eliminating shared risk factors, mainly tobacco use, unhealthy diet, physical inactivity and the harmful use of alcohol. According to WHO, a healthier food diet could be reached by reducing salt levels, eliminating industrially produced trans-fatty acids, decreasing saturated fats and limiting free sugars. A related consequence of unhealthy diet and physical inactivity is the rise in obesity prevalence. To tackle this public health problem, governments have tried to use public information campaigns in the aim to get people to change their food habits. These information campaigns may have positive impacts on food consumption (Weiss and Tschirhart, 1994; Snyder, 2007) or no impact (Santarossa, 2008) or may depend on sociodemographic factors (Nayga, 1997). However, they seem to have not been sufficiently effective at changing behavior (Cutler et al., 2003), and have failed to reverse the rising trend in obesity, diabetes and so on. In other areas legislation and taxation have proved more effective. For example, in the cigarettes or alcohol markets, legislation restricts sales to young people as well as advertising, and taxation increases the relative price of these goods (Adda and Cornaglia, 2006). Till now, tax (subsidy) policies designed to promote healthier food choices are almost unused. However, as they have been shown to be effective for cigarettes market, they might be considered as tools to influence consumer behavior to improve diets and therefore public health.

As the link between food intake and health is more and more recognized, there is a growing interest in the ex ante analysis of the health impacts of alternative food price policies. The general methodology used is a two-stage procedure which combines an economic model and a health model. The economic model is used to assess the impact on food or nutrient consumption of alternative tax or subsidy policies. Then, the health model assesses the impact of food consumption changes on health. For example, Marshall

[1] World Health Organization, 2008-2013 Action Plan for the Global Strategy for the Prevention and Control of Non-communicable Diseases. http://whqlibdoc.who.int/publications/2009/9789241597418_eng.pdf (accessed 2010, December 17)

(2000), Cash et al. (2005), Nnoaham et al. (2009), Purshouse et al. (2010), Dallongeville et al. (2010) use epidemiological models to assess the impact on death. Bonnet et al. (2009a), Allais et al. (2010) and, Smith et al. (2010) estimate the impact on the boby mass index, a measure of the obesity status. Jacobson and Brownell (2000), Chouinard et al. (2007), Bonnet and Requillart (2011), Griffith et al. (2010), Smed et al. (2007) and, Miao et al. (2010) look at the effect on some health related indicators such as diet quality or nutrient content. Whatever the way the second stage is developed, a key issue is the economic model used to predict how consumption will change in response to a tax policy.[2]

A common limit of almost all these analysis is the assumption of passive pricing, that is producers and retailers are supposed not to adjust product prices in response to the tax (subsidy) policy. Dallongeville et al. (2010) take into account a market effect due to a non perfectly elastic supply. However, they do not deal with any strategic pricing. The only example of integrating strategic pricing is Griffith et al. (2010) who account for a strategic behavior at the manufacturer level. However they ignore manufacturer and retailers relationships. Both the food and the retail food industries are characterized by large firms with market power, and therefore taxes are unlikely to be perfectly passed through to consumers. The industrial organization literature on retail pass-through of upstream cost changes (due to input taxes or cost shocks) conclude to imperfect pass-through (Bettendorf and Verboven, 2000; Goldberg and Verboven, 2001; Hellerstein and Villas-Boas, 2008; Goldberg and Hellerstein, 2008; Bonnet et al., 2009b; Nakamura and Zerom, 2010). A major explanation is the markup adjustment of manufacturers and retailers due to consumer substitution patterns, market structure, and market power in industries. The share of input considered in the production cost of products also plays an important role in the transmission of a tax. There also exist other explanations as nominal price stickiness and rigidities (fixed cost of repricing for example), long term contracts, or import quota constraints. Overall this literature suggests that final food prices are likely to be adjusted in response to a tax (subsidy) policy.[3]

[2] Some other methodologies are used to analyze health impacts. Among them, Schroeter et al. (2008) develop a model of consumer behavior including weight. Etile (2008) estimates a direct price - body mass index relationship and Fletcher et al. (2010) assess the direct effect of tax on soft drink consumption or weight measures in an ex-post analysis.

[3] This literature does not discuss the tax burden that is who pays the tax but rather focus on how final prices are affected by taxes or changes in input costs.

In this paper, we study the impact of taxing sugar sweetened beverages (SSB) industry. We choose this industry for many reasons. First, there is strong evidence that consumption of SSBs is a contributor to the 'epidemic' of obesity (Harnack et al., 1999; Malik et al., 2006). Second, the industry is highly concentrated making the possibility of strategic pricing more likely. 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 as both the soft drink industry and the retail industry are highly concentrated. This paper uses structural econometric models that accounts 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). As the nature of vertical relationships can impact on the retail price transmission (Bonnet et al. (2009b)), we then select the model fitting best the data to identify the close to reality contracts that firms used in this market. Using this selected model, we quantify the impact on prices, markets shares of the different SSBs and on household consumption of alternative taxation schemes. We consider an excise tax based on the sugar content, an ad valorem tax based on the sugar content as well as an uniform ad valorem tax. We find that firms behave differently when facing an ad valorem tax or an excise tax. Thus ad valorem taxes are undershifted to consumer prices while excise taxes are overshifted to consumer prices. In the later case, strategic pricing thus amplifies the impact of taxation on final consumption. Among the different tax systems analyzed in this paper, it is an excise tax based on the sugar content which has the largest impact on consumption. According to our quantitative results ignoring strategic pricing by the industry leads to misestimate the impact of taxation on consumption by about 15%-20% for regular products and 30%-40% for diet ones. Moreover, with ad valorem tax, ignoring strategic pricing leads to overestimate the impact on consumption while with excise tax it leads to underestimate the impact on consumption. This strongly militates for integrating strategic pricing in the ex-ante analysis of food taxation.

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

2 The Soft Drink market

In 2004, the turnover of the French soft drink 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 total beverages consumption in France which includes mineral water, alcohol, coffee, tea, drinking milk as well as fruit juices.[4] On average, soft drink consumption increased by 32% from 1994 to 2004.[5] Nevertheless, per capita consumption in France (42.5 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.[6] 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, 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

[4] Canadean 2004, website http://www.canadean.com/.

[5] Note that the consumption of diet drinks increased by 224% from 1994 to 2004. Nevertheless, their market share is still lower than 20%.

[6] Fruit juices do not contain added sugar while nectar contains less than 6% of added sugar.

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 two manufacturers (the alliance Coca Cola Enterprises and Cadbury Schweppes, the alliance Unilever and Pepsico) sharing 88.6% of the total production in 2004. Each of the manufacturers owns a brand portfolio even if Coca Cola and Pepsico are mainly involved in colas products and Unilever in iced tea. This situation is the result of two recent mergers: Coca-Cola Enterprises and Cadbury Schweppes merged their European drink industries in 1999, and Unilever and Pepsico came together and created Pepsi Lipton International in 2003.

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). According to our sample, the average consumption of regular soft drinks is 34 litres per person per year while the average consumption of diet products is 8 litres per person per year.

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^2) located in suburbs. Two retailers have mainly intermediate outlets (from 400 to 2500 m^2) 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.[7]

Market shares are defined as follows. We first consider the total market of SSB including soft drinks,

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

Table 1: **General Descriptive Statistics for Prices 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

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).

As shown on Table 1, products selected in our analysis represent 33.8% of the whole market. The average price over all products and all periods is 0.82 euros per liter. 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.

We provide some additional information on the soft drink market (that is excluding the 'outside good') in Annex (Tables 7 and 8). Brands 1 to 11 are NBs while brands 12 to 14 are PLs. The main NB has a market share larger than 30% (of the soft drink market) while the smallest one has less than 1% of the market. The market share of private label products vary between 6 and 12%. Average NB 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%. On 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]

4 Models and methods

To analyze strategic pricing in food chain, we follow the general methodology recently developed to analyze 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). Retail price transmission in the channel can be modified by the nature of contracts between firms of the sector or by vertical restraints considered as suggested by Bonnet et al. (2009b), we then consider 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 first estimate a cost model where calculated cost from each vertical relationships model is the endogenous variable and then use a non nested Rivers and Vuong (2002) test to select the best model. Finally, using the selected model, we simulate the impact on consumers prices and consumption of alternative tax policies. 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 consumer i buying product j in period t is given by

$$V_{ijt} = \beta_j + \gamma_t - \alpha_i p_{jt} + \rho_i l_j + \sum_{k=1}^{2} \tau_{ik} c_{k(j)} + \xi_{jt} + \varepsilon_{ijt}$$

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 product

[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.

j in 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 product j is a diet product and 0 otherwise) and ρ_i captures consumer i's taste for the diet characteristic, $c_{k(j)}$ is a dummy that takes 1 if product j belongs to product category k and τ_{ik} represent the consumer i's taste for category k, 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 categories of products considered. We assume their distributions are independent and parameters have the following specification:

$$\begin{pmatrix} \alpha_i \\ \rho_i \\ \tau_{i1} \\ \tau_{i2} \end{pmatrix} = \begin{pmatrix} \alpha \\ \rho \\ \tau_1 \\ \tau_2 \end{pmatrix} + \Sigma v_i$$

where $v_i = (v_i^{\alpha}, v_i^{\rho}, v_i^{\tau_1}, v_i^{\tau_2})'$ a 4x1 vector which captures the unobserved consumers characteristics. Σ is a 4×4 diagonal matrix of parameters $(\sigma_\alpha, \sigma_\rho, \sigma_{\tau_1}, \sigma_{\tau_2})$ that measure the unobserved heterogeneity of consumers. We suppose that $P_v(.)$ is a parametric distribution of v_i.

We can break down the indirect utility into a mean utility $\delta_{jt} = \beta_j + \gamma_t + \alpha p_{jt} + \rho l_j + \sum_{k=1}^{2} \tau_k c_{k(j)} + \xi_{jt}$ and a deviation from this mean utility $\mu_{ijt} = \left[p_{jt}, l_j, c_{1(j)}, c_{2(j)}\right] (\sigma_\alpha v_i^{\alpha}, \sigma_\rho v_i^{\rho}, \sigma_{\tau_1} v_i^{\tau_1}, \sigma_{\tau_2} v_i^{\tau_2})'$. 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 the 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):

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

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 $(\nu_i, \varepsilon_{i0t}, ..., \varepsilon_{iJt})$. We assume that P_ν is independently and normally distributed with mean α, ρ, τ_1, τ_2, and standard deviation σ_α, σ_ρ, σ_{τ_1}, σ_{τ_2} respectively.

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, 2010). In food retailing, upstream and downstream industries 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 maximized. Indeed, this provides 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). In this paper, we consider both linear pricing, characterized by Bertrand-Nash competition at downstream and upstream levels, and a set of two part-tariffs contracts where processors have all bargaining power.[9] The general framework of vertical relationships 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 case of two part tariffs, and finally we specify consumer price in addition to the fixed fee and wholesale price for contracts including 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 a positive fixed value if private

[9] This primarily affects how profits are shared (through the fixed fees) rather than the choices of prices which is what is studying here. According to Rey and Vergé (2010), equilibrium prices would be the same if retailers have all bargaining power. We will also justify this assumption when analyzing the results from the demand analysis.

labels are not acknowledged 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. 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 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 to distribute 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 marginalization) is now well known (refer to Sudhir, 2001; Berto Villas-Boas, 2007; Bonnet and Dubois, 2010). Let define μ_j the constant marginal cost to produce product j and G_f the set of products sold by 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 when retailer r sells only its private labels. By convention, we have $\widetilde{p}^r_j = +\infty$ for all brands sold by retailer r except for private labels. The vector of market shares $s(\widetilde{p}^r)$ thus corresponds to market shares when retailer r sold only his private labels.

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

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

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 maximization 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 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

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

[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.

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

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

where p_j^* stands for the price of NBs chosen 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:

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

Basically, the system of equations (4) and (5) characterizes 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 ($p_j-w_j-c_j=0$).

When resale price maintenance is not allowed, manufacturer f maximizes his 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 $\forall j\in G_f, \quad$ 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 characterized 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 (see (Berto Villas-Boas, 2007; Bonnet and Dubois, 2010)), two part tariffs with or without resale price maintenance ignoring the role of PLs (see (Bonnet and Dubois, 2010) for more details about margin expressions) and two part tariffs with or without resale price considering the role of PLs as described above.[13]

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 vertical interactions between manufacturers and retailers, 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 in period t for any supply model h, 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 estimated marginal costs and assume it takes the following specification:

$$C_{jt}^h = \sum_{k=1}^{K} \lambda_k^h W_{jt}^k + w_j^h + w_{jy(t)}^h + \tau_t^h + \eta_{jt}^h$$

where W_{jt} is a vector of inputs, w_j^h represents product fixed effects for model h, $w_{jy(t)}^h$ allows to differentiate the product fixed effect for product j across years and τ_t^h is a monthly fixed effect for model h. We suppose that $E(\eta_{jt}^h | W'_{jt}, w_j^h, w_{jy(t)}^h, \tau_t^h) = 0$ in order to identify and estimate consistently $\lambda_k^h, w_j^h, w_{jy(t)}^h$ and τ_t^h. To be consistent with the economic theory Gasmi et al. (1992), we impose the positivity of parameters λ_k^h and use a non linear least square method to estimate them. We use this cost function specification to test any pair of supply models C_{jt}^h and $C_{jt}^{h'}$ and infer which model is statistically the best using a non nested Rivers and Vuong test.

4.4 Simulations

Using the estimated marginal costs from the preferred model of contracts in the vertical chain as well as the other estimated structural parameters, one can simulate the policy experiments of interest (different tax scenarios). We denote $C_t = (C_{1t}, .., C_{jt}, .., C_{Jt})$ the vector of marginal costs for all products present in period t, where C_{jt} is given by $C_{jt} = p_{jt} - \Gamma_{jt} - \gamma_{jt}$.

[13] Note that we consider two versions of contracts with resale price maintenance: 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 of a change in the ad valorem tax (it goes up from τ to τ'), the new price equilibria is deduced from the following program:

$$\min_{\{p_{jt}^*\}_{j=1,..,J}} \left\| p_t^* - \widetilde{\Gamma}_t\left(p_t^*\right) - \widetilde{\gamma}_t\left(p_t^*\right) - C_t \right\| \tag{7}$$

where $\|.\|$ is the Euclidean norm in $\mathbb{R}^J$. The vector $\widetilde{\Gamma}_t\left(p_t^*\right) + \widetilde{\gamma}_t\left(p_t^*\right)$ are the wholesale and retail margins for the best supply model contracts and comes from the following profit maximisation program of manufacturers for national brands

$$\max_{\{p_k\}_{k\in G_f}} \sum_{j\in G_f} (w_j - \mu_j) s_j(p) + \sum_{j=1}^{J} \left(\frac{1+\tau}{1+\tau'} p_j - w_j - c_j\right) s_j(p) \tag{8}$$

and the following profit maximization program of retailers for private labels

$$\max_{\{p_k\}_{k\in \widetilde{S}_r}} \sum_{j\in \widetilde{S}_r} \left(\frac{1+\tau}{1+\tau'} p_j - \mu_j - c_j\right) s_j(p) + \sum_{j\in S_r \backslash \widetilde{S}_r} \left(\frac{1+\tau}{1+\tau'} p_j^* - w_j - c_j\right) s_j(p^*).^{14} \tag{9}$$

Introducing an excise tax based on the sugar content of each product is interpreted as an increase in the total marginal cost. The new price equilibria is deduced from

$$\min_{\{p_{jt}^*\}_{j=1,..,J}} \left\| p_t^* - \Gamma_t\left(p_t^*\right) - \gamma_t\left(p_t^*\right) - \widetilde{C}_t \right\| \tag{10}$$

where γ_t and Γ_t correspond respectively with the expression of retail and wholesale margins for the best supply model and $\widetilde{C}_t = C_t + T$ with $T = (T_1, .., T_j, .., T_J)$ the vector of excise tax.

5 Results on demand and vertical relationships

5.1 Demand results

We estimated the random coefficients logit model using the well-known GMM method proposed by Berry et al. (1995), Nevo (2000) and Nevo (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

[14] We obtain expressions (8) and (9) assuming that each marginal cost component is taxed to the same rate than the present ad valorem tax of food products. We are aware that this assumption could not be strictly correct but the lack of data on composition of the marginal cost of each product need it.

Table 2: **Results of the random-coefficients logit model.**

Coefficients (Std. error)	Mean	Standard Deviation
Price	-7.04(0.41)	2.35 (0.43)
Diet	0.52 (0.02)	0.26 (0.23)
Soda category	1.90 (0.02)	2.96 (0.45)
Ice tea category	-0.71 (0.02)	2.89 (0.59)
Coefficients δ_j, γ_t not shown		
Overidentifying Restriction Test (df)	19.43 (15)	

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.[15] 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 changed over manufacturers.

Table 2 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.[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. Given the value of the price standard deviation, only 0.1% of the distribution of the price coefficient is positive. The coefficient of the dummy identifying diet products is positive on average meaning that consumers like this characteristic. Whereas the soda category is preferred to the fruit drink category, consumers prefer fruit drinks to ice teas. However, standard deviations for both categories are large meaning that some consumers prefer them and some others do not prefer.

From the structural demand estimates, we are able to compute own and cross-price elasticities for each differentiated products (Table 3).[17] Own-price elasticities of demand for a brand vary between -1.66 and

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

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

[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.

-5.66 and is -4.13 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). Indeed, own-price elasticity of demand for regular brands is about -3.93 while it is about -4.65 for diet brands, these means are statistically different. 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 in the analysis the higher the elasticity of a single brand. Thus, Gasmi et al. (1992) estimate 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, Dube (2005) found elasticities ranging from -3 to -6 in the Denver area.

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 in same categories. Moreover, 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 annex Table 9 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 preferred 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 suggests that manufacturers have market power which is consistent with our main assumption on the non linear supply models which consists in giving all bargaining power to manufacturers.

Table 3: **Own and Cross Price Elasticities between Brands within the same Retailer**

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14
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
B1	-4.4514	0.0141	0.0077	0.0076	0.0012	0.0011	0.0013	0.0013	0.0014	0.0014	0.0014	0.0184	0.0020	0.0024
B2	0.0180	-4.4510	0.0140	0.0145	0.0021	0.0021	0.0025	0.0023	0.0027	0.0026	0.0026	0.0229	0.0026	0.0032
B3	0.2370	0.2341	-4.6570	0.2287	0.0394	0.0372	0.0479	0.0470	0.0483	0.0488	0.0486	0.2512	0.0388	0.0472
B4	0.0991	0.1038	0.0976	-4.8877	0.0165	0.0167	0.0213	0.0210	0.0230	0.0215	0.0215	0.1040	0.0161	0.0203
B5	0.0077	0.0073	0.0083	0.0081	-4.8089	0.1392	0.0189	0.0195	0.0190	0.0177	0.0180	0.0055	0.1124	0.0137
B6	0.0015	0.0015	0.0016	0.0016	0.0284	-4.9310	0.0039	0.0040	0.0042	0.0036	0.0037	0.0010	0.0229	0.0028
B7	0.0070	0.0069	0.0080	0.0084	0.0158	0.0157	-4.3426	0.0316	0.0298	0.0272	0.0279	0.0043	0.0093	0.0192
B8	0.0079	0.0078	0.0092	0.0097	0.0189	0.0190	0.0366	-4.4429	0.0361	0.0323	0.0333	0.0045	0.0103	0.0215
B9	0.0044	0.0047	0.0051	0.0056	0.0099	0.0109	0.0187	0.0196	-4.3680	0.0172	0.0176	0.0027	0.0059	0.0121
B10	0.0064	0.0064	0.0071	0.0074	0.0129	0.0130	0.0239	0.0244	0.0238	-4.0948	0.0230	0.0046	0.0089	0.0177
B11	0.0039	0.0039	0.0044	0.0045	0.0080	0.0081	0.0150	0.0155	0.0151	0.0141	-4.1880	0.0026	0.0053	0.0108
B12	0.0334	0.0337	0.0134	0.0127	0.0013	0.0013	0.0013	0.0012	0.0013	0.0016	0.0016	-2.7464	0.0038	0.0044
B13	0.0033	0.0032	0.0025	0.0024	0.0354	0.0357	0.0035	0.0033	0.0036	0.0038	0.0037	0.0037	-3.3226	0.0058
B14	0.0068	0.0068	0.0058	0.0059	0.0085	0.0085	0.0146	0.0141	0.0147	0.0152	0.0151	0.0066	0.0096	-2.9183
R means regular; D means diet ; B means brand														

5.2 Prefered model, price-cost margins and cost estimates

Thanks to demand estimates, we are able to compute price cost margins for each supply model. On the basis of Rivers and Vuong tests (see results in Table 12 in appendix) the best supply model is the model where manufacturers and retailers use two part tariffs contracts with resale price maintenance[18], the wholesale margin is equal to zero, and where private labels have no strategic role in the manufacturer-retailer relationships. It is coherent with the idea that in this industry brands are strong thus providing market power to upstream producers. According to these results, price cost margins are 45.25% of consumer price on average. These margins are relatively heterogeneous across brands (Table 10 in appendix). Average price-cost margins for PLs (38.65%) are significantly lower than for NBs (47.43%). Price-cost margins for diet brands (49.52%) are significantly higher than for regular products (43.63%). Price cost margins do not differ across retailers except for retailer 8 which exhibits lower margins since it only sells PLs and for retailer 9 which has an higher average margin since he sells brand 1 and 2 with high margins as well as PLs.

Estimated marginal cost calculated from the best supply model is 0.45€/litre on average. Average

[18]Resale price maintenance (RPM) is prohibited by competition authorities. However, in France, specific laws on the retail industry led to a situation where RPM was in practice possible to implement (Biscourp et al., 2008).

marginal cost of PLs (0.30€/litre) is lower than NBs (0.50€/litre).

6 Impact of taxation

We evaluate the impact of taxes taking into account consumer substitution patterns and strategic pricing of firms. We simulate three policy scenarios to determine which type of tax is the most efficient. In order to make comparable the scenarios, taxes are designed in such a way that in absence of consumers and firms reaction, the tax revenues are the same in the three cases. In scenario 1 we consider an uniform ad valorem tax on regular soft drinks. We assume that the VAT of regular products goes up to 19.6% instead of the 5.5%'s.[19] In scenario 2, we based the ad valorem tax on the sugar content of products. To get the same ex ante revenues as those in scenario 1, a 0.14% tax per gram of sugar per litre is applied. The final VAT now varies from 16.1% to 21.4% depending on the sugar content of products. In scenario 3, we design an excise tax based on the sugar content of products which is added to the current VAT tax. Ex ante revenue neutrality leads to design a 0.10 cents of euros per gram of sugar per litre of product. The excise tax ranges from 7.4 cents to 11 cents per litre of regular soft drink.

6.1 Impact on prices and consumption

Given the taxation system, we compute the new equilibria as described by (7) or (10). It should be acknowledged that the model integrates the brand portfolio of the manufacturers and retailers' assortment. However due to resale price maintenance the strategic choice of prices is made by manufacturers as explained above. Thus a manufacturer chooses his pricing policy for the whole set of products, internalizing substitution among his own set of products. We find that firms behave differently when facing an ad valorem tax or an excise tax (Table 4). When facing an ad valorem tax, they transfer to consumers less than the tax (scenarios 1 and 2). The consumer price integrating strategic pricing by firms is then

[19] The VAT of food products that prevails in France is 5.5% except for sweets and some chocolate products which are at the standard rate of 19.6%. In 2008, some French delegates proposed to increase VAT of SSBs to the standard rate of 19.6%.

lower than the consumer price assuming passive pricing that is assuming a perfect transmission of the additional tax to the consumers. According to our results, firms pass on to the consumers from 60 to 90% of the increase depending on the brand. Comparison of scenario 1 and 2 suggests that the 'pass-through' is brand specific as the ranking of the pass-through is the same in both cases. It does not seem to be strongly linked to the rate of taxation applied. PL products are mechanically less affected by ad valorem tax as their prices are significantly lower than those of NB products. Note also that the prices of diet products change even if those products do not support an additional tax. Firms act 'aggressively' in the sense that the price of diet products are reduced. Doing so, diet products gain significant market shares.

On the contrary, when facing an excise tax, firms transfer more than the tax to final consumers. Indeed the consumer price when integrating the strategic pricing by firms is larger than consumer price when assuming passive pricing by firms. Thus consumer price increases are 107 to 133% of the excise tax depending on the brand. As compared to scenarios 1 and 2, the ranking of pass-through to consumers is different.

Over shifting of a tax is in line with both theoretical and empirical results. From a theoretical point of view, Carbonnier (2006) showed that in a close oligopoly, if the second derivative of the demand is lower than 1, then the price adjustment of the excise tax is larger than one. Thus from a theoretical point of view, over transmission of a excise tax is possible. From an empirical point of view, this result is also consistent with the analysis of Campa and Goldberg (2006) who found that pass-through rates in the food industry in France are larger than one (1.41). Besley and Rosen (1999) also found, in the US case, that the soft drink industry overshifts tax changes.

Those price changes significantly affect brand market shares (table 4) as well as soft drink consumption (table 5). Thus with ad valorem tax consumption of regular soft drinks drops by about 3.5 litres per person per year which roughly corresponds to 1/5 of the consumption of those products. In this case, strategic pricing by firms tends to lower the impact on consumption as firms do not fully transmit the tax to consumers. With an excise tax, the impact on consumption is significantly larger as firms over transmit the tax. Consumption decreases by about 5.3 litres per person per year that is about 1/3 of

Table 4: **Impact of a decrease in the sugar price**

		Initial price	Passive Pricing		Strategic pricing		
			Price	Change in MS	Price	Pass-Through	Change in MS
		€/litre	€/litre	%	€/litre		%
S1	Brand 1	0.74 (0.11)	0.83 (0.12)	-26.85 (3.59)	0.79 (0.13)	0.58 (0.08)	-18.73 (6.16)
	Brand 2	0.72 (0.08)	0.72 (0.08)	30.29 (2.66)	0.69 (0.08)		+41.93 (0.04)
	Brand 3	0.87 (0.04)	0.99 (0.05)	-30.85 (1.86)	0.95 (0.05)	0.67 (0.04)	-25.54 (3.25)
	Brand 4	0.91 (0.05)	0.91 (0.05)	29.58 (2.59)	0.87 (0.05)		+41.72 (4.13)
	Brand 5	1.04 (0.08)	1.18 (0.09)	-31.22 (1.44)	1.15 (0.09)	0.77 (0.03)	-27.18 (2.43)
	Brand 6	1.05 (0.14)	1.05 (0.14)	29.18 (3.72)	1.01 (0.14)		+43.54 (5.89)
	Brand 7	1.02 (0.11)	1.16 (0.13)	-31.96 (0.98)	1.14 (0.13)	0.85 (0.05)	-30.19 (2.85)
	Brand 8	1.12 (0.08)	1.27 (0.09)	-32.51 (0.67)	1.26 (0.10)	0.90 (0.04)	-32.41 (1.96)
	Brand 9	1.00 (0.07)	1.00 (0.07)	18.21 (2.78)	0.97 (0.06)		29.16 (4.72)
	Brand 10	0.86 (0.07)	0.97 (0.08)	-30.52 (1.13)	0.95 (0.08)	0.77 (0.04)	-25.83 (2.61)
	Brand 11	0.90 (0.07)	1.03 (0.09)	-31.02 (1.06)	1.00 (0.09)	0.79 (0.05)	-27.20 (2.78)
	Brand 12	0.37 (0.08)	0.42 (0.10)	-9.41 (6.23)	0.41 (0.10)	0.62 (0.10)	-9.87 (6.94)
	Brand 13	0.53 (0.13)	0.61 (0.14)	-18.23 (5.86)	0.59 (0.14)	0.74 (0.08)	-16.05 (7.13)
	Brand 14	0.49 (0.09)	0.56 (0.10)	-21.96 (3.32)	0.54 (0.10)	0.73 (0.06)	-17.68 (4.40)
	OG			+8.62 (1.00)			+5.37 (0.72)
S2	Brand 1	0.74 (0.11)	0.85 (0.12)	-30.93 (3.74)	0.81 (0.13)	0.61 (0.08)	-22.72 (6.56)
	Brand 2	0.72 (0.08)	0.72 (0.08)	31.98 (2.84)	0.69 (0.08)		+44.57 (4.62)
	Brand 3	0.87 (0.04)	1.00 (0.05)	-33.50 (1.90)	0.96 (0.05)	0.68 (0.04)	-28.14 (3.36)
	Brand 4	0.91 (0.05)	0.91 (0.05)	31.20 (2.74)	0.87 (0.05)		+44.24 (4.42)
	Brand 5	1.04 (0.08)	1.14 (0.09)	-22.83 (1.92)	1.12 (0.09)	0.78 (0.04)	-20.20 (2.08)
	Brand 6	1.05 (0.14)	1.05 (0.14)	24.60 (3.10)	1.01 (0.14)		+37.45 (4.69)
	Brand 7	1.02 (0.11)	1.15 (0.12)	-29.30 (0.93)	1.13 (0.13)	0.83 (0.05)	-26.96 (2.75)
	Brand 8	1.12 (0.08)	1.28 (0.09)	-35.35 (0.69)	1.27 (0.10)	0.92 (0.04)	-35.86 (1.95)
	Brand 9	1.00 (0.07)	1.00 (0.07)	17.81 (2.72)	0.97 (0.06)		28.71 (4.60)
	Brand 10	0.86 (0.07)	0.97 (0.08)	-28.67 (1.10)	0.94 (0.08)	0.75 (0.04)	-23.68 (2.55)
	Brand 11	0.90 (0.07)	1.03 (0.09)	-32.78 (1.05)	1.01 (0.09)	0.81 (0.05)	-29.23 (2.75)
	Brand 12	0.37 (0.08)	0.42 (0.09)	-6.91 (7.00)	0.40 (0.09)	0.62 (0.10)	-8.01 (6.27)
	Brand 13	0.53 (0.13)	0.59 (0.14)	-13.45 (5.35)	0.58 (0.14)	0.74 (0.08)	-12.18 (6.14)
	Brand 14	0.49 (0.09)	0.55 (0.10)	-19.59 (4.03)	0.54 (0.10)	0.73 (0.06)	-15.86 (4.64)
	OG			+8.44 (0.94)			+5.23 (0.68)
S3	Brand 1	0.74 (0.11)	0.85 (0.11)	-31.87 (3.11)	0.87 (0.11)	1.16 (0.03)	-38.05 (0.03)
	Brand 2	0.72 (0.08)	0.72 (0.08)	34.65 (3.80)	0.71 (0.08)		48.76 (6.87)
	Brand 3	0.87 (0.04)	0.98 (0.04)	-27.18 (2.07)	1.00 (0.05)	1.16 (0.03)	-33.14 (2.83)
	Brand 4	0.91 (0.05)	0.91 (0.05)	32.17 (3.29)	0.89 (0.05)		47.17 (6.06)
	Brand 5	1.04 (0.08)	1.11 (0.08)	-12.86 (1.90)	1.13 (0.08)	1.14 (0.03)	-15.46 (2.66)
	Brand 6	1.05 (0.14)	1.05 (0.14)	24.40 (2.45)	1.03 (0.14)		38.04 (3.87)
	Brand 7	1.02 (0.11)	1.12 (0.11)	-21.00 (2.55)	1.14 (0.11)	1.25 (0.05)	-26.81 (2.43)
	Brand 8	1.12 (0.08)	1.23 (0.08)	-23.41 (1.99)	1.27 (0.08)	1.33 (0.05)	-31.42 (1.85)
	Brand 9	1.00 (0.07)	1.00 (0.07)	16.38 (2.07)	0.98 (0.06)		28.42 (3.81)
	Brand 10	0.86 (0.07)	0.95 (0.07)	-25.42 (1.67)	0.97 (0.07)	1.21 (0.03)	-30.65 (1.75)
	Brand 11	0.90 (0.07)	1.01 (0.07)	-27.62 (2.04)	1.04 (0.08)	1.25 (0.04)	-34.12 (1.81)
	Brand 12	0.37 (0.08)	0.47 (0.08)	-32.49 (9.87)	0.48 (0.08)	1.07 (0.03)	-35.37 (10.25)
	Brand 13	0.53 (0.13)	0.61 (0.13)	-23.59 (2.53)	0.62 (0.13)	1.10 (0.02)	-26.00 (2.50)
	Brand 14	0.49 (0.09)	0.58 (0.09)	-33.25 (2.68)	0.60 (0.09)	1.13 (0.01)	-37.05 (2.65)
	OG			+9.55 (1.08)			+10.15 (1.07)

Table 5: **Changes in SSB consumption (per person per year)**

	Initial values	Scenario 1		Scenario 2		Scenario 3	
		Passive	Strategic	Passive	Strategic	Passive	Strategic
Soft drink consumption (in litres)							
Regular products	16.41 (0.58)	-4.14 (0.18)	-3.47 (0.18)	-4.11 (0.18)	-3.49 (0.17)	-4.52 (0.11)	-5.28 (0.10)
Diet products	4.01 (0.17)	1.12 (0.04)	1.59 (0.04)	1.15 (0.04)	1.65 (0.04)	1.18 (0.03)	1.73 (0.03)
Sugar consumption (in grams)	1190 (795)	-405 (18)	-340 (18)	-409 (18)	-347 (17)	-443 (11)	-519 (12)

the initial consumption. Conversely consumption of diet soft drinks increases by 1.6 to 1.7 litres per person per year depending on the scenario. It should be noted that consumption of the outside good also increases by about 5% in scenarios 1 and 2 and by more than 10% in scenario 3.[20].

The price changes due to taxation induce significant substitution among products. Integrating strategic pricing in the evaluation of the impacts of taxation is thus important as firms do not perfectly transmit the tax to consumers. With ad valorem taxation, tax is undershifted to consumer prices while an excise tax is overshifted. Indeed with an ad valorem tax ignoring strategic pricing of firms would then lead to overestimate the impact on the regular soft drink consumption by 20% and to underestimate by 30% the increase in consumption of diet products. Conversely, when implementing an excise tax, ignoring strategic pricing would lead to underestimate by 15% and 40% the change in consumption of regular and diet products respectively.

6.2 Which tax is the most efficient?

There are different ways to evaluate the efficiency of the tax. A first criteria could be the impact on consumption of added sugar as the objective of such taxation might be to limit added sugar consumption as recommended by health authorities. From this point of view, it is the excise tax based on the sugar content which has the highest impact on sugar consumption (table 5). This is the consequence of both a better targeting of the tax and strategic pricing by firms which increases the impact on consumers. The tax is better targeted as the larger the sugar content the larger the tax. The ad valorem tax based

[20]It should be noted that in these simulations, we assume that the price of the outside option do no change. As the outside option is significantly composed of fruit juices, it is likely that those products would not be taxed as their consumption is recommended by health authorities (as being 'fruits') and because they do not contain 'added sugar'.

Table 6: **Impact on surplus (million Euros, over the whole period)**

	Scenario 1	Scenario 2	Scenario 3	Scenario 3a
Industry surplus	-77.2	-77.5	-62.9	-42.7
Consumer surplus	-59.0	-58.6	-103.0	-69.1
Tax revenue	75.3	74.5	68.0	50.8
Welfare	-60.9	-61.6	-97.6	-61.0

on sugar content adapts the rate of taxation to the sugar content but it failed to well target low priced products (PLs) as it is an ad valorem tax. Griffith et al. (2010) find a similar result when they study saturated fat taxation in the UK butter market: the excise tax is the most efficient at reducing butter consumption. A second criteria might be based on tax revenues.[21] In that case, the best choice is the one for which the impact on consumption is the lowest (uniform ad valorem tax) as the lower the decrease in consumption the larger the tax revenues (table 6). Note that tax revenues in scenarios 1 and 2 are very similar.

A third criteria is based on welfare impacts. From a welfare point of view scenarios 1 and 2 are superior to scenario 3. However the evaluation of welfare is somewhat biased as welfare calculation ignores the impact on health that would come from a reduction in added sugar consumption. Thus a negative welfare impact should not be interpreted as a 'bad policy' since the evaluation does not take into account the health effect which is assumed to be positive, correlated with the decrease in added sugar consumption but is not quantified. To make a valid comparison we thus need to compare scenarios leading to a similar reduction in sugar consumption. To do so, we designed a scenario 3a where the level of the per unit excise tax was calculated in order to get a final impact on sugar added consumption comparable with the one obtained in scenario 1 or 2 (that is a decrease by about 345 g added sugar per person per year). Welfare impacts of scenarios 1, 2 and 3a are very similar (table 6). However, distributive impacts differ among scenarios. An excise tax has a larger negative impact on consumer surplus while it less penalizes the industry.

[21] Remind that in scenarios 1, 2 and 3, the tax rate was calculated in order to generate identical revenues from the tax assuming fully inelastic demand.

7 Conclusion

As links between food intake and health are more and more recognized, there is a growing interest in the ex ante analysis of the health impacts of alternative food price policies. A frequently used methodology consists in a two-stage procedure which combines first an economic model and then a health model, meaning that assessing the impact on food consumption of simulated policies is an essential step in this methodology. Most analysis of taxation policies assume that producers fully transmit to consumers the tax or subsidy implicitly assuming passive pricing.

This paper provides a general methodology for assessing impacts of price policies on the food consumption taking into account pricing strategies of both manufacturers and retailers in the food chain. As an example, we analyze the impact of alternative ways for soft drink taxation. Using the recent development of empirical industrial organization, we have estimated a very flexible demand model, a random coefficients logit model, and several models of vertical relationships of the industry. We have shown that the most likely supply model is the one where manufacturers and retailers use two-part tariffs contracts with resale price maintenance and where private labels play no role in manufacturer/retailer relationships, meaning that manufacturers have a large market power. Using this model, we have simulated the impact on prices of alternative tax scenarios taking into account the strategic choice of firms. We found that firms behave differently when facing an ad valorem tax or an excise tax. Excise tax is overshifted to consumer prices while ad valorem tax is undershifted to consumer prices. We showed that ignoring strategic pricing would lead to over-estimate the change in regular products consumption by 20% when firms are facing an ad valorem tax while it would lead to under-estimate the change in consumption by about 15% when firms are facing an excise tax. We thus conclude that when analyzing food price policies, it is needed to take into account strategic pricing. This is an important point as it is frequently argued that assuming passive pricing provides an upper bound of the impact of the policy (e.g. Allais et al., 2010, p.238). This statement is true only if producers transmit less than the tax. From our results, we also conclude that an excise tax based on the sugar content is the most efficient way to limit soft drink consumption. Such a tax is equivalent to a taxation of the input (sugar) and is thus easy to put in place. It is interesting to note that a recent reform of the sugar policy in the EU is leading to a significant decrease in the sugar price. This reform of agricultural policy has its own logic but is at odds of would be recommended by an health policy. This clearly shows the need for developing more coherent public policies.

Our analysis suffers from some limits. First, simulations assume that the price of the outside option is unchanged which means that those products are not taxed and that producers of the outside option do not strategically reacts. A significant part of the outside option is composed of fruit juice which do not contain any added sugar. It is unlikely that those products would be taxed because their consumption is recommended as being 'fruits'. Moreover if the tax is put in place through sugar taxation they would not be concerned. However, the assumption of passive pricing remains. Even if this segment of production is much less concentrated than the production of soft drinks meaning that producers have less market power, it remains true that retailers might adapt prices of these products. Second, in a longer run, producers might also adapt the composition of their products to taxation. For example, if sweetened products are taxed according to their sugar content, this might provide incentives to producers to lower the sugar content of their product in order to avoid or limit the impact of taxes. Such a reaction would go in the right direction as long as the drop in added sugar per litre is not over compensated by an increase in consumption in response to lower taxes (which are based on the sugar content). Dealing with such an issue would require additional information on the composition of products, as well as integrating a choice of quality by producers. An issue which as far as we know is not integrated in the empirical models of industrial organization and then in analysis of public health policies.

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8 Appendices

8.1 Descriptive statistics on data

Table 7: **Descriptive Statistics for Prices and Market Shares by Brands.**

	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 Retailers.**

	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)

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:

$$\Pi^f = \sum_{j\in G_f} M(w_j - \mu_j)s_j(p) + \sum_{j=1}^{J} M(p_j - w_j - c_j)s_j(p) - \sum_{r=1}^{R}\sum_{j\in \widetilde{S}_r} M(\widetilde{p}_j^r - w_j - c_j)s_j(\widetilde{p}^r) - \sum_{j\notin G_f} F_j \quad (11)$$

8.3 Cross-price elasticities

Table 9: **Cross Price Elasticities between products**

Brands	Within a retailer	Between same brands
B1	0.007 (0.010)	0.013 (0.015)
B2	0.008 (0.007)	0.018 (0.013)
B3	0.101 (0.040)	0.233 (0.094)
B4	0.043 (0.024)	0.101 (0.054)
B5	0.030 (0.015)	0.137 (0.058)
B6	0.006 (0.005)	0.030 (0.024)
B7	0.016 (0.008)	0.030 (0.016)
B8	0.019 (0.010)	0.038 (0.021)
B9	0.010 (0.007)	0.020 (0.013)
B10	0.013 (0.007)	0.022 (0.011)
B11	0.008 (0.004)	0.014 (0.007)
B12	0.013 (0.024)	0.045 (0.058)
B13	0.008 (0.005)	0.065 (0.055)
B14	0.010 (0.005)	0.016 (0.009)

8.4 Price-cost margins

Table 10: **Margins for the prefered model.**

Brands	Total margins in %	Retailers	Total margins in %
B1	60.05 (5.84)	R1	45.18 (9.32)
B2	60.38 (5.24)	R2	45.79 (8.94)
B3	53.71 (2.51)	R3	44.37 (8.03)
B4	52.65 (2.71)	R4	44.67 (8.54)
B5	42.53 (1.72)	R5	46.47 (8.20)
B6	42.49 (3.70)	R6	44.39 (9.13)
B7	40.77 (1.15)	R7	44.02 (9.46)
B8	39.93 (0.70)	R8	31.89 (3.51)
B9	40.93 (0.96)	R9	58.21 (8.25)
B10	42.75 (1.28)		
B11	42.06 (1.33)		
B12	44.85 (10.59)		
B13	34.47 (8.65)		
B14	37.31 (5.50)		

8.5 Cost function

Table 11: **Estimation of the marginal cost function.**

Coefficients (Std. error)	$\mathbf{C}_{jt}$
Wages	8.81 (0.24)
Plastic	7.64 (0.23)
Aluminium	10.15 (0.34)
Water	10.53 (0.26)
Gazole	8.72 (0.26)
Sugar	0.08 (0.00)
Coefficients $w_j^h, w_{jy(t)}^h$and w_t^h not shown	
F test for w_j^h (p value)	99.91 (0.00)
F test for w_t^h (p value)	12.19 (0.00)

Results are provided at 10^{-4}.F tests for $w_{jy(t)}^h$ show that the year fixed effects by product are always significant.

8.6 Non-nested tests

Table 12: **Non-nested Rivers and Vuong tests.**

Rivers and Vuong Test Statistic T_n						
╲ H_2						
H_1	**2**	3	4	5	6	7
1	**-4.64**	-3.92	2.23	-4.15	-2.62	2.46
2		**11.90**	**2.27**	**4.75**	**7.07**	**2.51**
3			2.26	-2.20	4.18	2.50
4				-2.27	-2.25	0.68
5					8.19	2.50
6						2.49

Model 1 is double marginalisation, Model 2 is two part tariffs with resale price maintenance and $w = \mu$, Model 3 is two part tariffs with resale price maintenance and $p - w - c = 0$, Model 4 is two part tariffs without resale price maintenance, Model 5 is two part tariffs with resale price maintenance and $w = \mu$ and private labels buyer power, Model 6 is two part tariffs with resale price maintenance, $p - w - c = 0$ and private labels buyer power, Model 7 is two part tariffs without resale price maintenance and private labels buyer power