Two-Part Tariffs versus Linear Pricing Between Manufacturers and Retailers : Empirical Tests on Differentiated Products Markets

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Résumé

We present a methodology allowing to introduce manufacturers and retailers vertical contracting in their pricing strategies on a differentiated product market. We consider in particular two types of non linear pricing relationships, one where resale price maintenance is used with two part tariffs contracts and one where no resale price maintenance is allowed in two part tariffs contracts. Our contribution allows to recover price-cost margins from estimates of demand parameters both under linear pricing models and two part tariffs. The methodology allows then to test between different hypothesis on the contracting and pricing relationships between manufacturers and retailers in the supermarket industry using exogenous variables supposed to shift the marginal costs of production and distribution. We apply empirically this method to study the market for retailing bottled water in France. Our empirical evidence shows that manufacturers and retailers use non linear pricing contracts and in particular two part tariffs contracts with resale price maintenance. At last, thanks to the estimation of the our structural model, we present some simulations of counterfactual policy experiments like the change of ownership of some products between manufacturers.

Key words : vertical contracts, two part tariffs, double marginalization, collusion, competition, manufacturers, retailers, differentiated products, water, non nested tests.
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1 Introduction

Vertical relationships between manufacturers and retailers seem to be more and more important in the supermarket industry and in particular in food retailing. Competition analysis and issues related to market power on some consumption goods markets should involve the analysis of competition between producers but also between retailers and the whole structure of the industry. Consumer welfare depends crucially on these strategic vertical relationships and the competition or collusion degree of manufacturers and retailers. The aim of this paper is thus to develop a methodology allowing to estimate alternative structural models where the role of manufacturers and retailers is explicit in the horizontal and vertical strategic behaviors. Previous work on these issues generally does not account for the behavior of retailers in the manufacturers pricing strategies. One of the reasons is that information on wholesale prices and marginal costs of production or distribution are generally difficult to obtain and methods relying on demand side data, where only retail prices are observed, require the structural modelling of vertical contracts between manufacturers and retailers in an oligopoly model. Following Rosse (1970), researchers have thus tried to develop methodologies allowing to estimate price-cost margins that are necessary for market power analysis and policy simulations, using only data on the demand side, i.e. sales quantities, market shares and retail prices. Empirical industrial organization methods propose to address this question with the estimation of structural models of competition on differentiated products markets (see, for example, Berry, 1994, Berry, Levinsohn and Pakes, 1995, and Nevo, 1998, 2000, 2001, Ivaldi and Verboven, 2001 on markets such as cars, computers, and breakfast cereals). Until recently, most papers in this literature assume that manufacturers set prices and that retailers act as neutral pass-through intermediaries or that they charge exogenous constant margins. However, it seems unlikely that retailers do not use some strategic pricing. Chevalier, Kashyap and Rossi (2003) show the important role of distributors on prices through the use of data on wholesale and retail prices. Actually, the strategic role of retailers has been emphasized only recently in the empirical economics and marketing literatures. Goldberg and Verboven (2001), Mortimer

(2004), Sudhir (2001), Berto Villas Boas (2004) or Villas-Boas and Zhao (2004) introduce retailers' strategic behavior. For instance, Sudhir (2001) considers the strategic interactions between manufacturers and a single retailer on a local market and focuses exclusively on a linear pricing model leading to double marginalization. These recent developments introducing retailers' strategic behavior consider mostly cases where competition between producers and/or retailers remains under linear pricing. Berto Villas-Boas (2004) extends the Sudhir's framework to multiple retailers and considers the possibility that vertical contracts between manufacturers and retailers make pricing strategies depart from double marginalization by setting alternatively wholesale margins or retail margins to zero. Using recent theoretical developments due to Rey and Vergé (2004) that characterize pricing equilibria in the case of competition under non linear pricing between manufacturers and retailers (namely two part tariffs with or without resale price maintenance), we extend the analysis taking explicitly into account vertical contracts between manufacturers and retailers.

We then present how to test across different hypothesis on the strategic relationships between manufacturers and retailers in the supermarket industry competing on a differentiated products market. In particular, we consider two types of non linear pricing relationships, one where resale price maintenance is used with two part tariffs contracts and one where no resale price maintenance is allowed in two part tariffs (Rey and Vergé, 2004). Modelling explicitly optimal two part tariffs contracts (with or without resale price maintenance) allows to recover the pricing strategy of manufacturers and retailers and thus the total price-cost margins as functions of demand parameters without observing wholesale prices. Using non nested test procedures, we show how to test between the different models using exogenous variables that shift the marginal costs of production and distribution.

We apply this methodology to study the market for retailing bottled water in France and present the first formal empirical tests of such a model including non linear contracts between manufacturers and retailers. This market presents a high degree of concentration both at the manufacturer and retailer levels. It is to be noted that it is actually even more concentrated at the manufacturer level. Our empirical evidence shows that, in the French bottled water market, manufacturers and retailers use non linear pricing contracts and in particular two part tariffs contracts with resale price maintenance. At last, we also show how to simulate counterfactual policies with our structural model that consist in changing the ownership of products between manufacturers and retailers.

In section 2, we first present some stylized facts on the market for bottled water in France, an industry where the questions of vertical relationships and competition of manufacturers and retailers seem worth studying. Section 3 presents the main methodological contribution on the supply side. We show how price-cost margins can be recovered with demand parameters, in particular when taking explicitly into account two part tariffs contracts. Section 4 presents the demand model, its identification and the estimation method proposed as well as the testing method between the different models. Section 5 presents the empirical results, tests and simulations. A conclusion with future research directions is in section 6, and some appendices follow.

2 Stylized Facts on the Market for Bottled Water in France

The French market for bottled water is one of the more dynamic sector of the French food processing industry : the total production of bottled water has increased by 4% in 2000, and its turnover by 8%. Some 85% of French consumers drink bottled water, and over two thirds of French bottled water drinkers drink it more than once a day, a proportion exceeded only in Germany. The French bottled water sector is a highly concentrated sector, the first three main manufacturers (Nestlé Waters, Danone, and Castel) sharing 90% of the total production of the sector. Moreover, given the scarcity of natural springs, entry both for mineral or spring water is rather difficult in this market where there exist some natural capacity constraints. Compte, Jenny and Rey (2002) comment on the Nestlé/Perrier Merger case that took place in 1992 in Europe and point out that these capacity constraints are a factor of collusion by themselves in addition to the high concentration of the sector. This sector can be divided in two major segments : mineral water and spring water. Natural mineral water benefits some properties favorable to health, which are officially recognized. Composition must be guaranteed as well as the consistency of a set of qualitative criteria : mineral content, visual aspects, and taste. The mineral water can be marketed if it receives an agreement from the French Ministry of Health. The exploitation of a spring water source requires only a license provided by local authorities (*Prefectures*) and a favorable opinion of the local health committee. Moreover, the water composition is not required to be constant. The differences between the quality requirements involved in the certification of the two kinds of bottled water may explain part of the large difference that exists between the shelf prices of the national mineral water brands and the local spring water brands. Moreover, national mineral water brands are highly advertised. The bottled water products use mainly two kinds of differentiation. The first kind of differentiation stems from the mineral composition, that is the mineral salts content, and the second from the brand image conveyed through advertising. Actually, thanks to data at the aggregate level (Agreste, 1999, 2000, 2002) on food industries and the bottled water industry, one can remark (see the following Table) that this industry uses much more advertising than other food industries. Friberg and Ganslandt (2003) report an advertising to revenue ratio for the same industry in Sweden, i.e., 6.8% over the 1998-2001 period. For comparison, the highest advertising to revenue ratio in the US food processing industry corresponds to the ready-to-eat breakfast cereal industry and is of 10.8%. These figures may be interpreted as showing the importance of horizontal differentiation of products for bottled water.

Year	Bottled Water		All Food Industries	
	PCM	Advertising/Revenue	PCM	Advertising/Revenue
1998	17.38%	12.09%	6.32%	5.57%
1999	16.70%	14.91%	6.29%	6.81%
2000	13.61%	15.89%	3.40%	8.76%

Table : Aggregate Estimates of Margins and Advertising to Sales Ratios.

These aggregate data also allow to compute some accounting price-cost margins[1] defined as value added[2] (VA) minus payroll (PR) and advertising expenses (AD) divided by

[1] The underlying assumptions in the definition of these price-cost margins are that the marginal cost is constant and is equal to the average variable cost (see Liebowitz, 1982).

[2] Value added is defined as the value of shipments plus services rendered minus cost of materials, supplies and containers, fuel, and purchased electrical energy.

the value of shipments (TR). As emphasized by Nevo (2001), these accounting estimates can be considered as an upper bound to the true price-cost margins.

Recently, the degradation of the distribution network of tap water has led to an increase of bottled water consumption. This increase benefited to the cheapest bottled water, that is to the local spring water. For instance, the total volume of local spring water sold in 2000 reached closely the total volume of mineral water sold the same year. Households buy bottled water mostly in supermarkets : some 80% of the total sales of bottled water comes from supermarkets. Moreover, on average, these sales represent 1.7% of the total turnover of supermarkets, the bottled water shelf being one of the most productive. French bottled water manufacturers thus deal mainly their brands through retailing chains. These chains are also highly concentrated, the market share of the first five accounting for 80.7% of total food product sales. Moreover, these late years, like other processed food products, these chains have developed private labels to attract consumers. The increase in the number of private labels tends to be accompanied by a reduction of the market shares of the main national brands.

We thus face a relatively concentrated market for which the questions of whether or not producers may exert bargaining power in their strategic relationships with retailers is important. The study of competition issues and evaluation of markups, which is crucial for consumer welfare, has then to take into account the possibility that non linear pricing may be used between manufacturers and retailers. Two part tariffs are typically relatively simple contracts that may allow manufacturers to benefit from their bargaining position in selling national brands. Therefore, we study in the next section different alternative models of strategic relationships between multiple manufacturers and multiple retailers that are worth considering.

3 Competition and Vertical Relationships Between Manufacturers and Retailers

Before presenting our demand model, we present now the modelling of the competition and vertical relationships between manufacturers and retailers. Given the structure of the bottled water industry and the retail industry in France, we consider several oligopoly models with different vertical relationships. More precisely, we show how each supply model can be solved to obtain an expression for both the retailer's and manufacturer's price-cost margins just as a function of demand side parameters. Then using estimates of a differentiated products demand model, we will be able to estimate empirically these price-cost margins and we will show how we can test between these competing scenarios. A similar methodology has been used already for double marginalization scenarios considered below by Sudhir (2001) or Brenkers and Verboven (2004) or Berto Villas-Boas (2004) but none of the papers in this literature already considered the particular case of competition in two part tariffs using the recent theoretical insights of Rey and Vergé (2004).

Let's first introduce the notations. There are J differentiated products defined by the couple product-retailer corresponding to J' national brands and $J - J'$ private labels. We suppose there are R retailers competing in the retail market and F manufacturers competing in the wholesale market. We denote by S_r the set of products sold by retailer r and by F_f the set of products produced by firm f. In the following we present successively the different oligopoly models that we want to study.

3.1 Linear Pricing and Double Marginalization

In this model, the manufacturers set their prices first, and retailers follow, setting the retail prices given the wholesale prices. For private labels, prices are chosen by the retailer himself who acts as doing both manufacturing and retailing. We consider that competition is *à la* Nash-Bertrand. We solve this vertical model by backward induction considering the retailer's problem. The profit Π^r of retailer r in a given period (we drop the time subscript t for ease of presentation) is given by

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

where p_j is the retail price of product j sold by retailer r, w_j is the wholesale price paid by retailer r for product j, c_j is the retailer's (constant) marginal cost of distribution for product j, $s_j(p)$ is the market share of product j, p is the vector of all products retail prices and M is the size of the market. Assuming that a pure-strategy Bertrand-Nash equilibrium in prices exists and that equilibrium prices are strictly positive, the price of any brand j sold by retailer r must satisfy the first-order condition

$$s_j + \sum_{k \in S_r} (p_k - w_k - c_k) \frac{\partial s_k}{\partial p_j} = 0, \quad \text{for all } j \in S_r. \tag{1}$$

Now, we define I_r (of size $(J \times J)$) as the ownership matrix of the retailer r that is diagonal and whose elements $I_r(j, j)$ are equal to 1 if the retailer r sells products j and zero otherwise. Let S_p be the market shares response matrix to retailer prices, containing the first derivatives of all market shares with respect to all retail prices, i.e.

$$S_p \equiv \begin{pmatrix} \frac{\partial s_1}{\partial p_1} & \dots & \frac{\partial s_J}{\partial p_1} \\ \vdots & & \vdots \\ \frac{\partial s_1}{\partial p_J} & \dots & \frac{\partial s_J}{\partial p_J} \end{pmatrix}$$

In vector notation, the first order condition (1) implies that the vector γ of retailer r's margins, i.e. the retail price p minus the wholesale price w minus the marginal cost of distribution c, is[3]

$$\gamma \equiv p - w - c = - \left(I_r S_p I_r \right)^{-1} I_r s(p) \tag{2}$$

Remark that for private labels, this price-cost margin is in fact the total price cost margin $p - \mu - c$ which amounts to replace the wholesale price w by the marginal cost of production μ in this formula.

Concerning the manufacturers' behavior, we also assume that each of them maximize profit choosing the wholesale prices w_j of the product j he sells and given the retailers' response (1). The profit of manufacturer f is given by

$$\Pi^f = \sum_{j \in F_f} (w_j - \mu_j) s_j(p(w)) M$$

where μ_j is the manufacturer's (constant) marginal cost of production of product j. Assuming the existence of a pure-strategy Bertrand-Nash equilibrium in wholesale prices between manufacturers, the first order conditions are

$$s_j + \sum_{k \in F_f} \sum_{l=1,..,J} (w_k - \mu_k) \frac{\partial s_k}{\partial p_l} \frac{\partial p_l}{\partial w_j} = 0, \quad \text{for all } j \in F_f. \tag{3}$$

[3]Remark that in all the following, when we use the inverse of non invertible matrices, it means that we consider the matrix of generalized inverse which means that for example $\begin{bmatrix} 2 & 0 \\ 0 & 0 \end{bmatrix}^{-1} = \begin{bmatrix} 1/2 & 0 \\ 0 & 0 \end{bmatrix}$.

Consider I_f the ownership matrix of manufacturer f that is diagonal and whose element $I_f(j,j)$ is equal to one if j is produced by the manufacturer f and zero otherwise. We introduce P_w the $(J \times J)$ matrix of retail prices responses to wholesale prices, containing the first derivatives of the J retail prices p with respect to the J' wholesale prices w.

$$P_w \equiv \begin{pmatrix} \frac{\partial p_1}{\partial w_1} & .. & \frac{\partial p_J}{\partial w_{J'}} & .. & \frac{\partial p_J}{\partial w_1} \\ \vdots & & \vdots & & \vdots \\ \frac{\partial p_1}{\partial w_{J'}} & .. & \frac{\partial p_{J'}}{\partial w_{J'}} & .. & \frac{\partial p_J}{\partial w_{J'}} \\ 0 & .. & 0 & .. & 0 \\ 0 & .. & 0 & .. & 0 \end{pmatrix}$$

Remark that the last $J-J'$ lines of this matrix are zero because they correspond to private labels products for which wholesale prices have no meaning.

Then, we can write the first order conditions (3) in matrix form and the vector of manufacturer's margins is[4]

$$\Gamma \equiv w - \mu = -(I_f P_w S_p I_f)^{-1} I_f s(p) \tag{4}$$

The first derivatives of retail prices with respect to wholesale prices depend on the strategic interactions between manufacturers and retailers. Let's assume that the manufacturers set the wholesale prices and retailers follow, setting the retail prices given the wholesale prices. Therefore, P_w can be deduced from the differentiation of the retailer's first order conditions (1) with respect to wholesale price, i.e. for $j \in S_r$ and $k = 1,..,J'$

$$\sum_{l=1,..,J} \frac{\partial s_j(p)}{\partial p_l}\frac{\partial p_l}{\partial w_k} - 1_{\{k \in S_r\}}\frac{\partial s_k(p)}{\partial p_j} + \sum_{l \in S_r}\frac{\partial s_l(p)}{\partial p_j}\frac{\partial p_l}{\partial w_k} + \sum_{l \in S_r}(p_l - w_l - c_l)\sum_{s=1,..,J}\frac{\partial^2 s_l(p)}{\partial p_j \partial p_s}\frac{\partial p_s}{\partial w_k} = 0 \tag{5}$$

Defining $S_p^{p_j}$ the $(J \times J)$ matrix of the second derivatives of the market shares with respect to retail prices whose element (l,k) is $\frac{\partial^2 s_k}{\partial p_j \partial p_l}$, i.e.

$$S_p^{p_j} \equiv \begin{pmatrix} \frac{\partial^2 s_1}{\partial p_1 \partial p_j} & \cdots & \frac{\partial^2 s_J}{\partial p_1 \partial p_j} \\ \vdots & . & \vdots \\ \frac{\partial^2 s_1}{\partial p_J \partial p_j} & \cdots & \frac{\partial^2 s_J}{\partial p_J \partial p_j} \end{pmatrix}$$

We can write equation (5) in matrix form[5] :

$$P_w = I_r S_p (I_r - \widetilde{I}_r)\left[S_p I_r + I_r S_p' I_r + (S_p^{p_1} I_r \gamma | ... | S_p^{p_J} I_r \gamma) I_r\right]^{-1} \tag{6}$$

[4] Rows of this vector that correspond to private labels are zero.

[5] We use the notation $(a|b)$ for horizontal concatenation for a and b.

where $\gamma = p - w - c$. Equation (6) shows that one can express the manufacturer's price cost margins vector $\Gamma = w - \mu$ as depending on the function $s(p)$ by replacing the expression (6) for P_w in (4).

The expression (6) comes from the assumption that manufacturers act as Stackelberg leaders in the vertical relationships with retailers. In the case where we would assume that retailers and manufacturers set simultaneously their prices, we assume like Sudhir (2001) that only the direct effect of wholesale price on retail price matter through. Thus, the retailer's cost of input is accounted for in the retailer's choice of margin. In this case, the matrix P_w has to be equal to the following diagonal matrix

$$\begin{pmatrix} 1 & 0 & .. & .. & 0 \\ 0 & \ddots & \ddots & \ddots & \vdots \\ \vdots & \ddots & 1 & \ddots & \vdots \\ \vdots & .. & .. & 0 & 0 \\ 0 & .. & .. & 0 & 0 \end{pmatrix}$$

Then, again one can compute the price-cost margins of the retailer and the manufacturer under this assumption.

We can also consider the model where retailers and/or manufacturers collude perfectly just by modifying the ownership matrices. In the case of perfect price collusion between retailers, one can get the price cost margins of the retail industry by replacing the ownership matrices I_r in (2) by the identity matrix (the situation being equivalent to a retailer in monopoly situation). Similarly, one can get the price-cost margins vector of manufacturers in the case of perfect collusion by replacing the ownership matrix I_f in (4) by a diagonal matrix where diagonal elements are equal to one except for private labels goods.

3.2 Two-Part Tariffs

We now consider the case where manufacturers and retailers can sign two-part tariffs contracts. We assume that manufacturers have all the bargaining power. To prove the existence and characterize equilibria in this multiple common agency game is difficult. We could assume the existence of symmetric subgame perfect Nash equilibria but Rey and Vergé (2004) prove that some equilibrium exists under some assumptions on the game played. Actually, assume that manufacturers and retailers play the following game. First, manufacturers simultaneously propose two-part tariffs contracts to each retailer. These contracts consist in the specification of franchise fees and wholesale prices but also on retail prices in the case where manufacturers can use resale price maintenance. Thus we assume that, for each product, manufacturers propose the contractual terms to retailers and then, retailers simultaneously accept or reject the offers that are public information. If one offer is rejected, then all contracts are refused[6]. If all offers have been accepted, the retailers simultaneously set their retail prices, demands and contracts are satisfied. Assuming that offers of manufacturers are public is a convenient modelling assumption that can however be justified in France by the non-discrimination laws. Rey and Vergé (2004) show (in the two manufacturers - two retailers case) that there exist some equilibria to this (double) common agency game provided some conditions on elasticities of demand and on the shape of profit functions are satisfied[7]. They show that it is always a dominant strategy for manufacturers to set retail prices in their contracting relationship with retailers. Moreover, with resale price maintenance, the manufacturer can always replicate the retail price that would emerge and the profit it would earn without resale price maintenance. We also consider the case where resale price maintenance would not be used by manufacturers because in some contexts, like in France, resale price maintenance may be forbidden and manufacturers thus prefer not to use it.

In the case of these two part tariffs contracts, the profit function of retailer r is :

$$\Pi^r = \sum_{s \in S_r} [M(p_s - w_s - c_s)s_s(p) - F_s] \tag{7}$$

where F_s is the franchise fee paid by the retailer for selling product s.

Manufacturers set their wholesale prices to w_k and the franchise fees F_k and choose

[6] This assumption is strong but it happens that the characterization of equilibria in the opposite case is very difficult (see Rey and Vergé, 2004). However, this assumption means that we should observe all manufacturers trading with all retailers, which is the case for bottled water in France.

[7] These technical assumptions require that direct price effects dominate in demand elasticities such that if all prices increase, demand decreases. The empirical estimation of demand will confirm that this is the case for bottled water in France. Also it has to be that the monopoly profit function of the industry has to be single peaked as well as manufacturers revenue functions of the wholesale price vector.

the retail's prices in order to maximize profits which is for firm f equal to

$$\Pi^f = \sum_{k \in F_f} [M(w_k - \mu_k)s_k(p) + F_k] \tag{8}$$

subject to the retailers' participation constraints $\Pi^r \geq 0$, for all $r = 1, .., R$.

Since the participation constraints are clearly binding (Rey and Vergé, 2004) and manufacturers choose the fixed fees F_k given the ones of the other manufacturers, one can replace the expressions of the franchise fee F_k of the binding participation constraint (7) into the manufacturer's profit (8) and obtain the following profit for firm f (see details in appendix 7.1)

$$\sum_{k \in F_f} (p_k - \mu_k - c_k)s_k(p) + \sum_{k \notin F_f} (p_k - w_k - c_k)s_k(p)$$

Then, the maximization of this objective function depends on whether resale price maintenance is used or not by manufacturers.

Two part tariffs with resale price maintenance :

Since manufacturers can capture retail profits through the franchise fees and moreover set retail prices, the wholesale prices have no direct effect on profit. Rey and Vergé (2004) showed however that the wholesale prices influence the strategic behavior of competitors. They show that there exists a continuum of equilibria, one for each wholesale price vector. For each wholesale price vector w^*, there exists a unique symmetric subgame perfect equilibrium in which retailers earn zero profit and manufacturers set retail prices to $p^*(w^*)$, where $p^*(w^*)$ is a decreasing function of w^* equal to the monopoly price when the wholesale prices are equal to the marginal cost of production. For our purpose, we choose some possible equilibria among this multiplicity of equilibria. For a given equilibrium $p^*(w^*)$, the program of manufacturer f is now

$$\max_{\{p_k\} \in F_f} \sum_{k \in F_f} (p_k - \mu_k - c_k)s_k(p) + \sum_{k \notin F_f} (p_k^* - w_k^* - c_k)s_k(p)$$

Thus, we can write the first order conditions for this program as

$$\sum_{k \in F_f} (p_k - \mu_k - c_k)\frac{\partial s_k(p)}{\partial p_j} + s_j(p) + \sum_{k \notin F_f} (p_k^* - w_k^* - c_k)\frac{\partial s_k(p)}{\partial p_j} = 0 \quad \text{for all } j \in F_f \tag{9}$$

Then, depending on the wholesale prices, several cases can be considered. We will consider two cases of interest : first when wholesale prices are equal to the marginal cost of production ($w_k^* = \mu_k$), second, when wholesale prices are such that the retailer's price cost margins are zero ($p_k^*(w_k^*) - w_k^* - c_k = 0$).

First, when $w_k^* = \mu_k$, the first order condition (9) writes

$$\sum_{k \in F_f} (p_k - \mu_k - c_k) \frac{\partial s_k(p)}{\partial p_j} + s_j(p) + \sum_{k \notin F_f} (p_k^* - \mu_k - c_k) \frac{\partial s_k(p)}{\partial p_j} = 0 \quad \text{for all } j \in F_f$$

i.e.

$$\sum_k (p_k - \mu_k - c_k) \frac{\partial s_k(p)}{\partial p_j} + s_j(p) = 0 \quad \text{for all } j \in F_f$$

which gives in matrix notation :

$$I_f S_p(\gamma + \Gamma) + I_f s(p) = 0 \tag{10}$$

In the case of private labels products, retailers choose retail prices and bear the marginal cost of production and distribution, maximizing :

$$\max_{\{p_j\}_{j \in \widetilde{S}_r}} \sum_{k \in S_r} (p_k - \mu_k - c_k) s_k(p)$$

where $\widetilde{S}_r$ is the set of private label products of retailer r. Thus, for private label products, additional equations are obtained from the first order conditions of the profit maximization of retailers that both produce and retail these products. The first order conditions give

$$\sum_{k \in S_r} (p_k - \mu_k - c_k) \frac{\partial s_k(p)}{\partial p_j} + s_j(p) = 0 \quad \text{for all } j \in \widetilde{S}_r$$

which can be written

$$\sum_{k \in S_r} (p_k - \mu_k - c_k) \frac{\partial s_k(p)}{\partial p_j} + s_j(p) = 0 \quad \text{for all } j \in \widetilde{S}_r$$

In matrix notation, these first order conditions are : for $r = 1, .., R$

$$(\widetilde{I}_r S_p I_r)(\gamma + \Gamma) + \widetilde{I}_r s(p) = 0 \tag{11}$$

where $\widetilde{I}_r$ is the ownership matrix of private label products by retailer r.

We thus obtain a system of equations with (10) and (11) where $\gamma+\Gamma$ is unknown.

$$\begin{cases} I_f S_p(\gamma+\Gamma)+I_f s(p)=0 \text{ for } f=1,..,F \\ (\widetilde{I}_r S_p I_r)(\gamma+\Gamma)+\widetilde{I}_r s(p)=0 \text{ for } r=1,..,R \end{cases}$$

After solving the system (see appendix 7.2), we obtain the expression for the total price-cost margin of all products as a function of demand parameters and of the structure of the industry :

$$\gamma+\Gamma=-\left(\sum\nolimits_r I_r S_p' \widetilde{I}_r S_p I_r+\sum\nolimits_f S_p' I_f S_p\right)^{-1}\left(\sum\nolimits_r I_r S_p' \widetilde{I}_r+\sum\nolimits_f S_p' I_f\right) s(p) \tag{12}$$

Remark that in the absence of private label products, this expression would simplify to the case where the total profits of the integrated industry are maximized, that is

$$\gamma+\Gamma=-S_p^{-1}s(p) \tag{13}$$

because then $\sum_f I_f=I$.

This shows that two part tariffs contracts with RPM allow manufacturers to maximize the full profits of the integrated industry if retailers have no private label products.

Second, when wholesale prices w_k^* are such that $p_k^*(w_k^*)-w_k^*-c_k=0$, then (9) becomes

$$\sum_{k\in F_f}(p_k-\mu_k-c_k)\frac{\partial s_k(p)}{\partial p_j}+s_j(p)=0 \quad \text{for all } j\in F_f$$

In matrix notations, we get for all $f=1,..,F$

$$\gamma_f+\Gamma_f=(p-\mu-c)=-(I_f S_p I_f)^{-1} I_f s(p)$$

In this case, the profit maximizing strategic pricing of private labels by retailers is also taken into account by manufacturers when they choose fixed fees and retail prices of their own products in the contract. This implies that the prices of private labels chosen by retailers is such that they maximize their profit on these private labels and the total price cost margin $\widetilde{\gamma}_r+\widetilde{\Gamma}_r$ for these private labels will be such that

$$\widetilde{\gamma}_r+\widetilde{\Gamma}_r\equiv p-\mu-c=-\left(\widetilde{I}_r S_p \widetilde{I}_r\right)^{-1}\widetilde{I}_r s(p) \tag{14}$$

where $\widetilde{I}_r$ is the ownership matrices of private labels of retailer r.

However, among the continuum of possible equilibria, Rey and Vergé (2004) showed that the case where wholesale prices are equal to the marginal costs of production is the equilibrium that would be selected if retailers can provide a retailing effort that increases demand. Actually, in this case it is worth for the manufacturer to make the retailer residual claimant of his retailing effort which leads to select this equilibrium wholesale price.

Two part tariffs without resale price maintenance :

Let's consider now that resale price maintenance cannot be used by manufacturers. Since they cannot choose retail prices, they only set wholesale prices in the following maximization program

$$\max_{\{w_k\}\in F_f} \sum_{k\in F_f}(p_k-\mu_k-c_k)s_k(p)+\sum_{k\notin F_f}(p_k-w_k-c_k)s_k(p)$$

Then the first order conditions are for all $i\in F_f$

$$\sum_k \frac{\partial p_k}{\partial w_i}s_k(p)+\sum_{k\in F_f}\left[(p_k-\mu_k-c_k)\sum_j \frac{\partial s_k}{\partial p_j}\frac{\partial p_j}{\partial w_i}\right]+\sum_{k\notin F_f}\left[(p_k-w_k-c_k)\sum_j \frac{\partial s_k}{\partial p_j}\frac{\partial p_j}{\partial w_i}\right]=0$$

which gives in matrix notation

$$I_fP_ws(p)+I_fP_wS_pI_f\times(p-\mu-c)+I_fP_wS_p(I-I_f)(p-w-c)=0$$

This implies that the total price cost margin $\gamma+\Gamma=p-\mu-c$ is such that for all $j=1,..,J$:

$$\gamma+\Gamma=(I_fP_wS_pI_f)^{-1}\left[-I_fP_ws(p)-I_fP_wS_p(I-I_f)(p-w-c)\right] \quad (15)$$

that allows us to estimate the price-cost margins with demand parameters using (2) to replace $(p-w-c)$ and (6) for P_w. Remark again that the formula (2) provides directly the total price-cost margin obtained by each retailer on its private label.

We are thus able to obtain the several expressions for price-cost margins at the manufacturing or retail levels under the different models considered and function of the demand parameters.

4 Differentiated Products Demand

4.1 The Random Utility Demand Model

We now describe our model of differentiated product demand. We use a standard random utility model. Actually, denoting V_{ijt} the utility for consumer i of buying good j

at period t, we assume that it can be represented by

$$\begin{aligned} V_{ijt} &= \theta_{jt} + u_{jt} + \varepsilon_{ijt} \\ &= \delta_j + \gamma_t - \alpha p_{jt} + u_{jt} + \varepsilon_{ijt} \text{ for } j = 1, ., J \end{aligned}$$

where θ_{jt} is the mean utility of good j at period t, u_{jt} a product-time specific unobserved utility term and ε_{ijt} a (mean zero) individual-product-period-specific utility term representing the deviation of individual's preferences from the mean θ_{jt}.

Moreover, we assume that θ_{jt} is the sum of a mean utility δ_j of product j common to all consumers, a mean utility γ_t common to all consumers and products at period t (due to unobserved preference shocks to period t) and an income disutility αp_{jt} where p_{jt} is the price of product j at period t.

Consumers may decide not to purchase any of the products. In this case they choose an outside good for which the mean part of the indirect utility is normalized to 0, so that $V_{i0t} = \varepsilon_{i0t}$. Remark that the specification used for θ_{jt} is such that one could also consider that the mean utility of the outside good depends also on its time varying price p_{0t} without changing the identification of the other demand parameters. Actually, adding $-\alpha p_{0t}$ to the outside good mean utility is equivalent to adding αp_{0t} to all other goods mean utility, which would amount to replace γ_t by $\gamma_t + \alpha p_{0t}$.

In the bottled water market in France, it seems that customers make a clear difference between two groups of bottled water : Mineral water and spring water, such that it makes sense to allow customers to have correlated preferences over such groups [8]. Our demand model incorporates this observation. Indeed, we model the distribution of the individual-specific utility term ε_{ijt} according to the assumptions of a Generalized Extreme Value (GEV) model (McFadden, 1978)[9]. We assume that the bottled water market can be partitioned into G different groups ($G = 2$), each sub-group g containing J_g products ($\sum_{g=1}^{G} J_g = J$). With an abuse of notation, we will also denote J_g the set of products belonging to the sub-group g. Since products belonging to the same subgroup share a

[8]Friberg and Ganslandt (2003) observe the same structure for bottled water demand in Sweden.

[9]Recent papers (Slade, 2004, and Benkers and Verboven, 2004) make the same assumption when modeling the demand side of the markets they analyze.

common set of unobserved features, consumers may have correlated preferences over these features. A GEV model allows a general pattern of dependence among the unobserved attributes and yields tractable closed form for the choice probabilities. Assuming that consumers choose one unit of the good that maximizes utility, the distributional assumptions of a GEV model[10] yield the following choice probabilities or market shares for each product j, as a function of the price vector $p_t = (p_{1t}, p_{2t}, ..., p_{Jt})$

$$s_{jt}(p_t) = P\left(V_{ijt} = \max_{l=0,1,.,J}(V_{ilt})\right) = s_{jt/g}(p_t) \times s_{gt}(p_t)$$

where $s_{gt}(p_t)$ and $s_{jt/g}(p_t)$ denote respectively the probability choice of group g and the conditional probability of choosing good j conditionally on purchasing a good in group g. The expressions of these probabilities are given by

$$\begin{aligned} s_{jt/g}(p_t) &= \frac{\exp \frac{\theta_{jt}+u_{jt}}{1-\sigma_g}}{\sum_{j\in J_g} \exp \frac{\theta_{jt}+u_{jt}}{1-\sigma_g}} \\ s_{gt}(p_t) &= \frac{\left(\sum_{j\in J_g} \exp \frac{\theta_{jt}+u_{jt}}{1-\sigma_g}\right)^{1-\sigma_g}}{\sum_{g=0}^{G}\left(\sum_{j\in J_g} \exp \frac{\theta_{jt}+u_{jt}}{1-\sigma_g}\right)^{1-\sigma_g}} \end{aligned}$$

The conditions on McFadden's (1978) GEV model required for the model to be consistent with random utility maximization are that each similarity index σ_g belongs to the unit interval $[0, 1]$. When σ_g goes to 1, preferences for products of the same subgroup become perfectly correlated meaning that these products are perceived as perfect substitutes. When σ_g goes to 0, preferences for all products become uncorrelated, and the model reduces to a simple multinomial logit model. At the aggregate demand level, the parameter σ_g allows to assess to which extent competition is localized between products from the same subgroup. This specification is more flexible than a simple multinomial logit specification (since it includes it as a special case). Actually, in the special case where $\sigma_g = 0$ for

[10] The cumulative distribution function of the vector of the individual-specific utility terms ε_{ijt} for individual i at time t is given by $F(\varepsilon) = exp(-G(e^{-\varepsilon_{i1t}}, \ldots, e^{-\varepsilon_{iJt}}))$ where the function G is defined as follows

$$G(y) = \sum_{g=1}^{G}[\sum_{j\in J_g} y_j^{\frac{1}{1-\sigma_g}}]^{1-\sigma_g}.$$

The parameter σ_g associated to the subgroup g measures the degree of similarity of the unobserved attributes in this subgroup.

$g = 1, .., G$[11], we obtain a simple multinomial logit model which amounts to assume that ε_{ijt} is i.i.d. with a type I extreme value distribution. Then we have

$$s_{jt}(p_t) = \frac{\exp\left[\theta_{jt} + u_{jt}\right]}{1 + \sum\limits_{j=1,.,J} \exp\left[\theta_{jt} + u_{jt}\right]}$$

The nested logit model can be interpreted as a special case of the random coefficients logit models estimated by Berry, Levinsohn and Pakes (1995), Nevo (2001), Petrin (2002) and others. McFadden and Train (2000) show that any random utility model can be arbitrarily approximated by a random coefficient logit model. The nested logit model introduces restrictions on the underlying model but they are testable and this model has the advantage to be much more tractable (Berry, 1994, and Berry and Pakes, 2001).

4.2 Identification and Estimation of the Econometric Model

Our method relies on two structural estimations, first, on the demand model and then on the cost equation. In appendix 7.4, we argue that estimating the model parameters in a single step thanks to the overall price equation would need to make too strong assumptions.

Following Berry (1994) and Verboven (1996), the random utility model introduced in the previous section leads to the following equations on the aggregate market shares of good j at time t

$$\begin{aligned} \ln s_{jt} - \ln s_{0t} &= \theta_{jt} + \sigma_g \ln s_{jt|g} + u_{jt} \\ &= \delta_j + \gamma_t - \alpha p_{jt} + \sigma_g \ln s_{jt|g} + u_{jt} \end{aligned} \tag{16}$$

where $s_{jt|g}$ is the relative market share of product j at period t in its group g and s_{0t} is the market share of the outside good at time t. In the particular case of the simple multinomial logit model, this equation becomes

$$\ln s_{jt} - \ln s_{0t} = \delta_j + \gamma_t - \alpha p_{jt} + u_{jt} \tag{17}$$

Remark that the full set of time fixed effects γ_t captures preferences for bottled water relative to the outside good, and can thus be thought of as accounting for macro-economic

[11] The function G defined in footnote ? becomes $G(y) = \sum_{j=1}^{J} y_j$.

fluctuations (like the weather) that affect the decision to buy bottled water[12] but also as accounting for the outside good price variation across periods.
The error term u_{jt} captures the remaining unobserved product valuations varying across products and time, e.g. due to unobserved variations in advertising.

The usual problem of endogeneity of price p_{jt} and relative market shares $s_{jt|g}$ has to be handled correctly in order to identify and estimate the parameters of these models. Our identification strategy then relies on the use of instrumental variables. Actually, thanks to the collection of data on wages, oil, diesel, packaging material and plastic prices over the period of interest, we construct instruments for prices p_{jt} that are interactions between product dummies and these prices (the vector of these instruments is denoted z_{jt}). Using characteristics of bottled water instead of product dummies crossed with input prices gives similar empirical results. The identification then relies on the fact that these input prices affect the product prices because they are correlated with input costs but are not correlated with the idiosyncratic unobserved shocks to preferences u_{jt}. For the simple logit model, this set of instrumental variables is sufficient, but for the nested logit model, one has also to take into account the endogeneity of the relative (within group) market shares. For these relative market shares, our strategy relies on the fact that the contemporaneous correlation between $\ln s_{jt|g}$ and unobserved shocks u_{jt}, which is the source of the endogeneity problem, can be controlled for with some suitable projection of the relative market shares on the hyperplane generated by some observed lagged variables. In order to take into account this endogeneity problem, we denote $Z_{jt} = (1_{j=1}, .., 1_{j=J}, \varsigma_{jt-1}, z_{jt})$ the vector of variables on which we project the right hand side endogenous variables (including dummy variables for products), where ς_{jt-1} results form the projection of the lagged variable $\ln s_{jt-1|g}$ on the hyperplane orthogonal to the space spanned by a set of product fixed effects and the variable $\ln s_{jt-2|g}$. ς_{jt-1} is thus the residual of the regression

$$\ln s_{jt-1|g} = \pi_j + \beta \ln s_{jt-2|g} + \varsigma_{jt-1}$$

[12] Similarly, in all the regressions they perform, Friberg and Ganslandt (2003) include also a dummy for the high demand season, i.e. summer.

Then, the identification of the coefficients of (16) relies on the orthogonality condition

$$E\left(Z_{jt}u_{jt}\right)=0$$

The identification and estimation of these demand models then permits to evaluate own and cross price elasticities in this differentiated product demand model.

4.3 Testing Between Alternative Models

We now present how to test between the alternative models once we have estimated the demand model and obtained the different price-cost margins estimates according to their expressions obtained in the previous section.

Denoting by h the different models considered, for product j at time t under model h, we denote γ_{jt}^h the retailer price cost margin and Γ_{jt}^h the manufacturer price cost margin. Using C_{jt}^h for the sum of the marginal cost of production and distribution ($C_{jt}^h=\mu_{jt}^h+c_{jt}^h$) we can estimate this marginal cost using prices and price cost margins with

$$C_{jt}^h=p_{jt}-\Gamma_{jt}^h-\gamma_{jt}^h \tag{18}$$

Let's now assume that these marginal costs are affected by some exogenous shocks W_{jt}, we use the following specification

$$C_{jt}^h=p_{jt}-\Gamma_{jt}^h-\gamma_{jt}^h=\left[\exp(\omega_j^h+W_{jt}'\lambda_h)\right]\eta_{jt}^h$$

where ω_j^h is an unknown product specific parameter, W_{jt} are observable random shock to the marginal cost of product j at time t and η_{jt}^h is an unobservable random shock to the cost. Taking logarithms, we get

$$\ln C_{jt}^h=\omega_j^h+W_{jt}'\lambda_h+\ln\eta_{jt}^h \tag{19}$$

Assuming that $corr(\ln\eta_{jt}^h,W_{jt})=corr(\ln\eta_{jt}^h,\omega_j^h)=0$, one can identify and estimate consistently ω_j^h, λ_g, and η_{jt}^h.

Now, for any two models h and h', one would like to test one model against the other, that is test between

$$p_{jt}=\Gamma_{jt}^h+\gamma_{jt}^h+\left[\exp(\omega_j^h+W_{jt}'\lambda_h)\right]\eta_{jt}^h$$

and

$$p_{jt} = \Gamma_{jt}^{h'} + \gamma_{jt}^{h'} + \left[\exp(\omega_j^{h'} + W'_{jt}\lambda_{h'})\right] \eta_{jt}^{h'}$$

Using non linear least squares

$$\min_{\lambda_h,\omega_j^h} Q_n^h(\lambda_h,\omega_j^h) = \min_{\lambda_h,\omega_j^h} \frac{1}{n}\sum_{j,t}\left(\ln \eta_{jt}^h\right)^2 = \min_{\lambda_h,\omega_j^h} \frac{1}{n}\sum_{j,t}\left[\ln\left(p_{jt} - \Gamma_{jt}^h - \gamma_{jt}^h\right) - \omega_j^h - W'_{jt}\lambda_h\right]^2$$

Then, we use non nested tests (Vuong, 1989, and Rivers and Vuong, 2002) to infer which model h is statistically the best. The tests we use consist in testing models one against another. The test of Vuong (1989) applies in the context of maximum likelihood estimation and thus would apply in our case if one assumes log-normality of η_{jt}^h. Rivers and Vuong (2002) generalized this kind of test to a broad class of estimation methods including non linear least squares. Moreover, the Vuong (1989) or the Rivers and Vuong (2002) approaches do not require that either competing model be correctly specified under the tested null hypothesis. Indeed, other approaches such as Cox's tests (see, among others, Smith, 1992) require such an assumption, i.e. that one of the competing model accurately describes the data. This assumption cannot be sustained when dealing with a real data set like ours.

Taking any two competing models h and h', the null hypothesis is that the two non nested models are *asymptotically equivalent* when

$$H_0 \ : \ \lim_{n\to\infty}\left\{\bar{Q}_n^h(\overline{\lambda}_h,\overline{\omega}_j^h) - \bar{Q}_n^{h'}(\overline{\lambda}_{h'},\overline{\omega}_j^{h'})\right\} = 0$$

where $\bar{Q}_n^h(\overline{\lambda}_h,\overline{\omega}_j^h)$ (resp. $\bar{Q}_n^{h'}(\overline{\lambda}_{h'},\overline{\omega}_j^{h'})$) is the expectation of a lack-of-fit criterion $Q_n^h(\lambda_h,\omega_j^h)$ (i.e. the opposite of a goodness-of-fit criterion) evaluated for model h (resp. h') at the pseudo true values of the parameters of this model, denoted by $\overline{\lambda}_h,\overline{\omega}_j^h$ (resp. $\overline{\lambda}_{h'},\overline{\omega}_j^{h'}$). The first alternative hypothesis is that h is *asymptotically better* than h' when

$$H_1 \ : \ \lim_{n\to\infty}\left\{\bar{Q}_n^h(\overline{\lambda}_h,\overline{\omega}_j^h) - \bar{Q}_n^{h'}(\overline{\lambda}_{h'},\overline{\omega}_j^{h'})\right\} < 0$$

Similarly, the second alternative hypothesis is that h' is *asymptotically better* than h when

$$H_2 \ : \ \lim_{n\to\infty}\left\{\bar{Q}_n^h(\overline{\lambda}_h,\overline{\omega}_j^h) - \bar{Q}_n^{h'}(\overline{\lambda}_{h'},\overline{\omega}_j^{h'})\right\} > 0$$

The test statistic T_n captures the statistical variation that characterizes the sample values of the lack-of-fit criterion and is then defined as a suitably normalized difference of the sample lack-of-fit criteria, i.e.

$$T_n = \frac{\sqrt{n}}{\hat{\sigma}_n^{hh'}} \left\{ Q_n^h(\widehat{\lambda}_h, \widehat{\omega}_j^h) - Q_n^{h'}(\widehat{\lambda}_{h'}, \widehat{\omega}_j^{h'}) \right\}$$

where $Q_n^h(\widehat{\lambda}_h, \widehat{\omega}_j^h)$ (resp. $Q_n^{h'}(\widehat{\lambda}_{h'}, \widehat{\omega}_j^{h'})$) is the sample lack-of-fit criterion evaluated for model h (resp. h') at the estimated values of the parameters of this model, denoted by $\widehat{\lambda}_h, \widehat{\omega}_j^h$ (resp. $\widehat{\lambda}_{h'}, \widehat{\omega}_j^{h'}$). $\hat{\sigma}_n^{hh'}$ denotes the estimated value of the variance of the difference in lack-of-fit. Since our models are strictly non nested, Rivers and Vuong showed that the asymptotic distribution of the T_n statistic is standard normal. The selection procedure involves comparing the sample value of T_n with critical values of the standard normal distribution[13]. In the empirical section, we will present evidence based on these different statistical tests.

5 Econometric Estimation and Test Results

5.1 Data and Variables

Our data were collected by the company SECODIP (*Société d'Étude de la Consommation, Distribution et Publicité*) that conducts surveys about households' consumption in France. We have access to a representative survey for the years 1998, 1999, and 2000. These data contain information on a panel of nearly 11000 French households and on their purchases of mostly food products. This survey provides a description of the main characteristics of the goods and records over the whole year the quantity bought, the price, the date of purchase and the store where it is purchased. In particular, this survey contains information on all bottled water purchased by these French households during the three years of study. We consider purchases of the seven most important retailers which represent 70.7% of the total purchases of the sample. We take into account the most important brands, that is five national brands of mineral water, one national brand of spring water, one retailer private label brand of mineral water and one retailer private

[13] If α denotes the desired size of the test and $t_{\alpha/2}$ the value of the inverse standard normal distribution evaluated at $1-\alpha/2$. If $T_n < t_{\alpha/2}$ we reject H_0 in favor of H_1 ; if $T_n > t_{\alpha/2}$ we reject H_0 in favor of H_2. Otherwise, we do not reject H_0.

label spring water. The purchases of these eight brands represent 71.3% of the purchases of the seven retailers. The national brands are produced by three different manufacturers : *Danone*, *Nestlé* and *Castel*. This survey presents the advantage of allowing to compute market shares that are representative of the national French market thanks to a weighting procedure of the available household panel. Then, the market shares are defined by a weighted sum of the purchases of each brand during each month of the three years considered divided by the total market size of the respective month. The market share of the outside good is defined as the difference between the total size of the market and the shares of the inside goods. We consider all other non-alcoholic refreshing drinks as the outside good. Therefore, the market size consists in all non-alcoholic refreshing drinks such as bottled water (including sparkling and flavored water), tea drinks, colas, tonics, fruit drinks, sodas lime. Our data thus allow to compute this market size across all months of the study. It is clearly varying across periods and shows that the market for non-alcoholic drinks is affected by seasons or for example the weather.

We consider eight brands sold in seven distributors, which gives more than 50 differentiated products in this national market. The number of products in our study thus varies between 51 and 54 during the 3 years considered. Considering the monthly market shares of all of these differentiated products, we get a total of 2041 observations in our sample. For each of these products, we compute an average price for each month. These prices are in euros per liter (even if until 2000, the money used was the French Franc). Table 1 presents some first descriptive statistics on some of the main variables used.

Variable	Mean	Median	Std. dev.	Min.	Max
Per Product Market share (all inside goods)	0.005	0.003	0.006	4.10^{-6}	0.048
Per Product Market share : Mineral Water	0.004	0.003	0.003	10^{-6}	0.048
Per Product Market share : Spring Water	0.010	0.007	0.010	10^{-5}	0.024
Price in €/liter	0.298	0.323	0.099	0.096	0.823
Price in €/liter : Mineral Water	0.346	0.343	0.060	0.128	0.823
Price in €/liter : Spring Water	0.169	0.157	0.059	0.096	0.276
Mineral water dummy (0/1)	0.73	1	0.44	0	1
Market Share of the Outside Good	0.71	0.71	0.04	0.59	0.78

Table 1 : Summary Statistics

We also use data from the French National Institute for Statistics and Economic Studies (INSEE) on the plastic price, on a wage salary index for France, on oil and diesel prices and on an index for packaging material cost. Over the time period considered (1998-2000), the wage salary index always raised while the plastic price index first declined during 1998 and the beginning of 1999 before raising again and reaching the 1998 level at the end of 2000. Concerning the diesel price index, it shows quite an important volatility with a first general decline during 1998 before a sharp increase until a new decline at the end of 2000. Also, the packaging material cost index shows important variations with a sharp growth in 1998, a decline at the beginning of 1999 and again an important growth until the end of 2000. Interactions of these prices with the dummies for the type of water (spring versus mineral) will serve as instrumental variables as they are supposed to affect the marginal cost of production and distribution of bottled water. Actually, it is likely that labor cost is not the same for the production of mineral or spring water but it is also known in this industry that the plastic quality used for mineral or spring water is usually not the same which is also likely to affect their bottling and packaging costs. Also, the relatively important variations of all these price indices during the period of study suggests a potentially good identification of our cost equations.

5.2 Demand Results

We estimate the demand model (16) which is the following

$$\ln s_{jt} - \ln s_{0t} = \delta_j + \gamma_t - \alpha p_{jt} + \sigma_g \ln s_{jt|g} + u_{jt}$$

as well as the simple logit demand model (17) using two stage least squares in order to instrument the endogenous variables p_{jt} and $\ln s_{jt|g}$. Results are in Table 2. F tests of the first stage regressions show that our instrumental variables are well correlated with the endogenous variables. Moreover, the Sargan test of overidentification validates the exclusion of excluded instruments from the main equation. The price coefficient has the expected sign in both specifications and in the case of the nested logit model, the coefficients σ_g actually belongs to the $[0, 1]$ interval as required by the theory. Moreover, since one can reject that parameters σ_g are zero, it is clear that the nested logit specification is preferred to the simple logit one for this market of bottled water.

Variable	Multinomial Logit	Nested Logit
Price (α) (Std. error)	5.47 (0.44)	4.11 (0.077)
Mineral water σ_g (Std. error)		0.68 (0.025)
Spring water σ_g (Std. error)		0.59 (0.018)
Coefficients δ_j, γ_t not shown		
F test that all $\delta_j = 0$ (p value)	219.74 (0.000)	55.84 (0.000)
Wald test that all $\gamma_t = 0$ (p value)	89.89 (0.0000)	64.50 (0.0034)
Sargan Test of overidentification (p value)	6.30 (0.18)	8.38 (0.08)

Table 2 : Estimation Results of Demand Models

In appendix 7.5, we present the first stage regression results for the estimation of this demand model using two stage least squares.

Given the demand estimates, it is interesting to note that we find estimates of unobserved product specific mean utilities δ_j. Using these parameters estimates, one can look at their correlation with observed product characteristics using ordinary least squares. This is done in Table 3 below.

Fixed Effects δ_j	Multinomial Logit	Nested Logit
Mineral Water (0/1) (Std. error)	-1.98 (0.13)	-0.89 (0.08)
Minerality (Std. error)	0.83 (0.05)	0.63 (0.03)
Manufacturer 1 (Std. error)	5.76 (0.12)	3.89 (0.08)
Manufacturer 2 (Std. error)	5.23 (0.12)	3.57 (0.08)
Manufacturer 3 (Std. error)	-3.83 (0.09)	-3.00 (0.06)
Constant (Std. error)	-2.56 (0.06)	-2.08 (0.04)
F test (p value)	3300.50 (0.00)	3926.94 (0.00)

Table 3 : Regression of fixed effects on the product characteristics

Table 3 shows that the product specific constant mean utility δ_j is increasing with the minerality of water and that the identity of the manufacturer of the bottled water affects this mean utility. This is probably due to image, reputation and advertising of the manufacturing brands. Remark that if one does not control for the manufacturer identity this mean utility is larger for mineral water rather than spring water but it is not the case anymore when one introduces these manufacturer dummy variables.

Finally, once we obtained our structural demand estimates, we can compute price elasticities of demand for our differentiated products[14]. Table 4 presents the different average

[14]Formulas of the different elasticities are given in appendix 7.8.

elasticities obtained for the simple multinomial logit or the nested logit demand model. All of them have the expected sign and the magnitude of own-price elasticities are much larger than that of cross-price elasticities. It is interesting to see that in the unrestricted specification (nested logit), the average own price elasticities are larger than in the restricted (multinomial logit) model. Also average own price elasticities for mineral water and spring water are almost proportional to average prices of these segments (nearly twice for mineral water than for spring water) both in the case of the multinomial logit model and the more flexible nested logit model. As expected, the cross-price elasticities are larger within each segment of product than across segments.

Elasticities (η_{jk})	**Multinomial Logit**	**Nested Logit**
All bottle water	Mean (Std. Error)	Mean (Std. Error)
Own-price elasticity	-10.80 (3.52)	-19.95 (6.60)
Cross-price elasticity within group	0.05 (0.04)	0.44 (0.34)
Cross-price elasticity across group		0.04 (0.03)
Mineral water		
Own-price elasticity	-12.53 (2.03)	-23.16 (3.85)
Cross-price elasticity within group	0.05 (0.04)	0.41 (0.28)
Cross-price elasticity across group		0.04 (0.03)
Spring water		
Own-price elasticity	-6.07 (2.14)	-11.14 (4.06)
Cross-price elasticity within group	0.06 (0.05)	0.51 (0.44)
Cross-price elasticity across group		0.04 (0.04)

Table 4 : Summary of Elasticities Estimates

These elasticities are quite large but it seems consistent with the fact that our model considers a very precise degree of differentiation. Actually, even for non sparkling spring and natural water, we end up with 56 products as we consider that the brand and the supermarket chain distributor are differentiation characteristics of a bottle of water. It is not surprising to find that these products are importantly substitutable.

However, if one looks at some group level elasticities, one finds much lower absolute values for these elasticities. The Table 5 shows these elasticities for the groups of mineral water or spring water or for different brands or firms (a firm produces several brands on this market). It appears that the total price elasticity of the group of mineral water goes down to -7.40 instead of an average of -23.16 at the product level and that for spring water it goes down from -11.14 to -3.41.

Table 5 : Own-Price Elasticities (nested logit case)

Set of products[15] Group g	Average elasticity $\frac{1}{\#\{k\in g\}}\sum_{k\in g}\eta_{gk}$	Total elasticity $\sum_{k\in g}\eta_{gk}$
Mineral Water	-0.21	-7.40
Spring Water	-0.27	-3.41
Mineral Water NB 1	-0.26	-1.74
Mineral Water NB 2	-0.15	-1.02
Mineral Water NB 3	-0.20	-1.27
Mineral Water NB 4	-0.27	-1.80
Mineral Water NB 5	-0.39	-2.61
Spring Water NB	-0.22	-1.40
Mineral Water PL	0.07	0.16
Spring Water PL	-0.28	-1.85
Firm f	$\frac{1}{\#\{k\in f\}}\sum_{k\in f}\eta_{fk}$	$\sum_{k\in f}\eta_{fk}$
Danone	-0.99	-13.11
Nestlé	-1.64	-32.37
Castel	-0.22	-1.40

5.3 Price-Cost Margins and Non Nested Tests

Once one has estimated the demand parameters, we can use the formulas obtained in section 3 to compute the price cost margins at the retailer and manufacturer levels, or the total price cost margins, for all products, under the various scenarios considered. We presented several models that seem worth of consideration with some variants on manufacturers or retailers behavior. Among the different models with double marginalization or two part tariffs, we consider the models described in the following table. Each scenario can be described according to the assumptions made on the manufacturers behavior (collusive or Nash), the retailers behavior (collusive or Nash) and the vertical interaction which can be Stackelberg or Nash under double marginalization or under two part tariffs contracts (with RPM or not) :

[15] NB means National Brand and PL means Private Label.

Models	**Retailers Behavior**	**Manufacturers Behavior**	**Vertical Interaction**
Double marginalization			
Model 1	Collusion	Nash	Nash
Model 2	Collusion	Nash	Stackelberg
Model 3	Collusion	Collusion	Nash
Model 4	Collusion	Collusion	Stackelberg
Model 5	Nash	Nash	Nash
Model 6	Nash	Nash	Stackelberg
Model 7	Nash	Collusion	Nash
Model 8	Nash	Collusion	Stackelberg
Two Part Tariffs			
Model 9	Nash	Nash	RPM[16] $(w = \mu)$
Model 10	Nash	Nash	RPM $(p = w + c)$
Model 11	Collusion	Collusion	RPM $(p = w + c)$
Model 12	Nash	Nash	no RPM

Note that in the case of private labels products, we assume that the retailer is also the producer which amounts in our models to assume that the behavior for pricing private labels is equivalent to the one of a manufacturer perfectly colluding with the retailer for this good. Of course, only one price cost margin is then computed for these private label goods because it has then no meaning to compute wholesale price and retail price margins separately.

Tables 6 and 7 then present the averages[17] of product level price cost margins estimates under the different models with either the logit demand (Table 6) or the more general nested logit demand (Table 7). It is worth noting that price cost margins are generally lower for mineral water than for spring water. As done by Nevo (2001), one could then compare price cost margins with accounting data to evaluate their empirical validity and also eventually test which model provides the most realistic result. However, the lack of data both on retailers or manufacturers margins prevents such analysis. Moreover accounting data only provide an upper bound for price-cost margins.

[16] RPM means resale price maintenance. Vertical contracts are such that the producer is always a Stackelberg leader.

[17] Note that the average price-cost margin at the retailer level plus the average price-cost margin at the manufacturer level do not sum to the total price cost margin because of the private labels products for which no price cost margin at the manufacturer level is computed, the retailer price cost margin being then equal to the total price cost margin.

Price-Cost Margins (% of retail price p)		Mineral Water		Spring Water	
		Mean	Std.	Mean	Std.
Double Marginalization					
Model 1	Retailers	11.63	2.29	26.47	9.53
	Manufacturers	8.53	1.02	27.67	2.35
	Total	**19.60**	**2.57**	**39.94**	**23.34**
Model 2	Retailers	11.63	2.29	26.47	9.53
	Manufacturers	9.09	1.07	30.00	2.97
	Total	**20.13**	**2.64**	**41.08**	**24.57**
Model 3	Retailers	11.63	2.29	26.47	9.53
	Manufacturers	10.34	1.31	32.95	3.03
	Total	**21.29**	**3.00**	**42.51**	**26.02**
Model 4	Retailers	11.63	2.29	26.47	9.53
	Manufacturers	13.55	1.98	43.29	5.39
	Total	**24.30**	**3.87**	**47.55**	**31.41**
Model 5	Retailers	8.54	1.63	19.44	6.87
	Manufacturers	8.53	1.02	27.67	2.35
	Total	**16.52**	**2.31**	**32.92**	**20.73**
Model 6	Retailers	8.54	1.63	19.44	6.87
	Manufacturers	8.62	1.03	28.78	2.83
	Total	**16.61**	**2.33**	**33.46**	**21.31**
Model 7	Retailers	8.54	1.63	19.44	6.87
	Manufacturers	10.34	1.31	32.95	3.03
	Total	**18.21**	**2.75**	**35.49**	**23.41**
Model 8	Retailers	8.54	1.63	19.44	6.87
	Manufacturers	11.01	1.42	35.40	3.99
	Total	**18.85**	**2.90**	**36.68**	**24.69**
Two part Tariffs with RPM					
Model 9	Nash and $w = \mu$	**11.63**	**2.29**	**26.47**	**9.53**
Model 10	Nash and $p = w + c$	**8.54**	**1.01**	**27.59**	**2.32**
Model 11	Collusion and $p = w + c$	**10.31**	**1.30**	**32.78**	**3.04**
Two-part Tariffs without RPM					
Model 12	Retailers	8.54	1.63	19.44	6.87
	Manufacturers	2.09	0.39	7.01	1.62
	Total	**10.33**	**1.28**	**33.12**	**3.10**

Table 6 : Price-Cost Margins by groups for the Multinomial Logit Model

Price-Cost Margins (% of retail price p)		Mineral Water		Spring Water	
		Mean	Std.	Mean	Std.
Double Marginalization					
Model 1	Retailers	15.09	2.96	34.42	12.41
	Manufacturers	6.71	0.80	23.85	2.32
	Total	**21.36**	**2.74**	**46.01**	**24.33**
Model 2	Retailers	15.09	2.96	34.42	12.41
	Manufacturers	8.26	1.14	26.82	4.26
	Total	**22.81**	**2.80**	**47.45**	**25.98**
Model 3	Retailers	15.09	2.96	34.42	12.41
	Manufacturers	12.39	1.56	28.06	2.91
	Total	**26.66**	**3.66**	**48.05**	**26.47**
Model 4	Retailers	15.09	2.96	34.42	12.41
	Manufacturers	34.33	5.63	46.89	8.06
	Total	**47.15**	**9.71**	**57.20**	**36.37**
Model 5	Retailers	5.51	2.02	12.19	4.34
	Manufacturers	6.71	0.80	23.85	2.32
	Total	**11.78**	**2.05**	**23.78**	**16.31**
Model 6	Retailers	5.51	2.02	12.19	4.34
	Manufacturers	7.07	2.52	28.92	12.21
	Total	**12.09**	**3.09**	**26.25**	**20.50**
Model 7	Retailers	5.51	2.02	12.19	4.34
	Manufacturers	12.39	1.56	28.06	2.91
	Total	**17.08**	**3.18**	**25.83**	**18.44**
Model 8	Retailers	5.51	2.02	12.19	4.34
	Manufacturers	14.05	2.72	35.18	15.38
	Total	**19.13**	**4.29**	**29.29**	**24.27**
Two part Tariffs with RPM					
Model 9	Nash and $w = \mu$	**15.09**	**2.96**	**34.41**	**12.41**
Model 10	Nash and $p = w + c$	**6.94**	**1.82**	**15.77**	**8.06**
Model 11	Collusion and $p = w + c$	**12.24**	**2.14**	**17.81**	**10.20**
Two-part Tariffs without RPM					
Model 12	Retailers	5.51	2.02	12.19	4.34
	Manufacturers	3.84	1.66	14.12	3.46
	Total	**9.06**	**2.36**	**18.82**	**11.60**

Table 7 : Price-Cost Margins (averages by groups) for the Nested Logit Model

After estimating the different price cost margins for the models considered, one can recover the marginal cost C^h_{jt} using equation (18) and then estimate the cost equation (19). The empirical results of the estimation of these cost equations are in appendix 7.6. They are useful mostly in order to test which model fits best the data. We thus performed the non nested tests presented in 4.3. Tables 8 and 9 present the Rivers and Vuong tests for the logit or nested logit demand models. In both cases, the statistics of test[18] show

[18] Recall that for a 5% size of the test, we reject H_0 in favor of H_2 if T_n is lower than the critical value -1.64 and that we reject H_0 in favor of H_1 if T_n is higher than the critical value 1.64.

that the best model appears to be the model 10, that is the case where manufacturers use two part tariffs contracts with resale price maintenance. The Vuong (1989) tests based on the maximum likelihood estimation of the cost equations under normality draw the same inference about the best model (see Tables of results of these tests in appendix 7.7).

Rivers and Vuong Test Statistic $T_n = \frac{\sqrt{n}}{\hat{\sigma}_n}\left(Q_n^2(\hat{\Theta}_n^2) - Q_n^1(\hat{\Theta}_n^1)\right) \rightarrow N(0,1)$											
$\diagdown$	H_2										
H_1	2	3	4	5	6	7	8	9	10	11	12
1	2.51	2.60	4.59	-2.64	-2.63	-2.40	-1.94	-2.71	-2.86	-2.78	-2.78
2		2.07	4.19	-3.20	-3.20	-3.05	-2.72	-3.26	-3.35	-3.30	-3.30
3			4.29	-3.35	-3.35	-3.18	-3.11	-3.42	-3.53	-3.47	-3.47
4				-5.16	-5.16	-5.04	-4.98	-5.20	-5.28	-5.24	-5.24
5					0.57	9.27	3.36	-1.94	-8.27	-6.45	-6.96
6						6.11	3.52	-2.58	-9.64	-7.30	-6.48
7							2.14	-8.12	-9.59	-9.23	-9.31
8								-3.65	-4.36	-4.06	-3.99
9									-9.45	-7.42	-6.79
10										10.61	8.82
11											0.74

Table 8 : Results of the Rivers and Vuong Test for the Multinomial Logit Model

Rivers and Vuong Test Statistic : $T_n = \frac{\sqrt{n}}{\hat{\sigma}_n}\left(Q_n^2(\hat{\Theta}_n^2) - Q_n^1(\hat{\Theta}_n^1)\right) \rightarrow N(0,1)$											
$\diagdown$	H_2										
H_1	2	3	4	5	6	7	8	9	10	11	12
1	5.90	6.22	5.99	-9.85	-9.51	-9.78	-9.14	-9.98	-10.10	-10.02	-9.71
2		5.59	5.77	-9.82	-9.50	-9.75	-9.23	-9.83	-10.09	-10.01	-9.74
3			5.32	-8.82	-8.58	-8.75	-8.36	-8.55	-9.09	-9.02	-8.81
4				-7.62	-7.49	-7.55	-7.36	-7.23	-7.80	-7.74	-7.64
5					5.73	6.91	6.62	8.85	-10.65	-9.01	-4.70
6						-0.22	4.36	7.63	-9.70	-8.79	-6.61
7							5.10	8.62	-9.48	-9.76	-6.51
8								5.71	-8.65	-8.39	-6.84
9									-9.60	-9.53	-8.62
10										6.83	11.16
11											3.43

Table 9 : Results of the Rivers and Vuong Test for the Nested Logit Model

Finally, the non rejected model tells that manufacturers use two part tariffs with retailers and moreover (as predicted by the theory) that they use resale price maintenance in their contracting relationships although it is in principle not legal in France.

For this model, the estimated total price cost margins (price minus marginal cost of production and distribution), are relatively low with an average of 6.94% for the mineral water and 15.77% for spring water. These figures are lower than the rough accounting estimates that one can get from aggregate data (see section 2). As Nevo (2001) remarks the accounting margins only provide an upper bound of the true values. Moreover, the accounting estimates do not take into account the marginal cost of distribution while our structural estimates do. Thus, these empirical results seem then quite realistic and consistent with the bounds provided by accounting data. In absolute values, the price-cost margins are on average close for mineral water and for spring water because mineral water is on average more expensive. Actually, the absolute margins are on average of 0.022 € for mineral water and 0.017 € for spring water. For our best model, we can look at the average price-cost margins for national brands products versus private labels products. In the case of mineral water, the average price-cost margins for national brands and private labels are not statistically different and about the same with an average of 4.72% for national brands and of 10.18% for private labels. However, in the case of natural spring water, it appears that price-cost margins for national brands are larger than for private labels with an average of 23.86% instead of 8.13%.

5.4 Simulating Counterfactual Policy Experiments

The estimation of the structural demand and cost parameters now allows to simulate some counterfactual policy experiments. Let's present first the method used to simulate these counterfactual policy experiments and then the particular policies and simulation results considered.

We denote by I_f, I_r, the true ownership matrices for manufacturers and retailers and h the preferred pricing equilibrium according to our data (two part tariffs model with RPM). The previous estimation and inference allow to estimate a vector of marginal costs (of production and distribution) for the preferred model. 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 obtained by

$$C_{jt} = p_{jt} - \Gamma_{jt} - \gamma_{jt}$$

Then, given these marginal costs and the other estimated structural parameters, one can simulate some policy experiment denoted (I_f^*, I_r^*) where I_f^* stands for some ownership matrices of manufacturers, and I_r^* stands for some ownership matrices of retailers. Actually, using equilibrium conditions, it is possible to simulate the policy experiment that would consist in modifying some elements of the ownership matrices.

Thus let's consider the policy experiment (I_f^*, I_r^*) where product ownership have been changed to I_f^*, I_r^*. We simply have to solve for equilibrium prices p_t^* as solutions of

$$p_t^* + (I_f^* S_p(p_t^*))^{-1} I_f^* s(p_t^*) = C_t \tag{20}$$

Market shares $s(p_t^*)$ and their derivatives $S_p(p_t^*)$ depend of course on the equilibrium prices p_t^* and the demand model specification, which is given by

$$\begin{aligned} s_{jt}(p_t^*) &= s_{jt/g}(p_t^*) \times s_{gt}(p_t^*) \text{ with} \\ s_{jt/g}(p_t^*) &= \frac{\exp \frac{\theta_{jt}(p_t^*)+u_{jt}}{1-\sigma_g}}{\sum_{j\in J_g} \exp \frac{\theta_{jt}(p_t^*)+u_{jt}}{1-\sigma_g}} \text{ and } s_{gt}(p_t^*) = \frac{\left(\sum_{j\in J_g} \exp \frac{\theta_{jt}(p_t^*)+u_{jt}}{1-\sigma_g}\right)^{1-\sigma_g}}{\sum_{g=0}^{G} \left(\sum_{j\in J_g} \exp \frac{\theta_{jt}(p_t^*)+u_{jt}}{1-\sigma_g}\right)^{1-\sigma_g}} \end{aligned}$$

The estimation of the parameters of our demand model allows to compute $\theta_{jt}(p_{jt}^*) + u_{jt}$. Using the fact that $\theta_{jt}(p_{jt})$ is additive linear in price, we have

$$\theta_{jt}(p_{jt}^*) + u_{jt} = \theta_{jt}(p_{jt}) + u_{jt} + \alpha\left(p_{jt} - p_{jt}^*\right)$$

Then, we can use the fact that $\theta_{jt}(p_{jt}) + u_{jt}$ is identified from the data thanks to the equality $\theta_{jt}(p_{jt}) + u_{jt} = \ln s_{jt} - \ln s_{0t} - \sigma_g \ln s_{jt|g}$.

Thus solving the non linear equation (20) whose unknowns are the prices p_{jt}^*, one obtain simulated equilibrium prices under such policy. Markets shares are obtained using the simulated prices.

For a policy experiment (I_f^*, I_r^*), we thus look for the solution vector p_t^* of

$$\min_{\{p_{jt}^*\}_{j=1,..,J}} \left\| p_t^* + (I_f^* S_p(p_t^*))^{-1} I_f^* s(p_t^*) - C_t \right\|$$

where $\|.\|$ is a norm of $\mathbb{R}^J$. In practice we will take the euclidean norm in $\mathbb{R}^J$.

Then, one can compute the consumer surplus using the usual formula for nested logit

$$CS_t(p_t) = E\left[\max_j V_{ijt}(p_t)\right] = \ln\left(\sum_{g=1}^{G} \exp\left[(1-\sigma_g)\ln\left(\sum_{j\in J_g} \exp\frac{\theta_{jt}+u_{jt}}{1-\sigma_g}\right)\right]\right)$$

and evaluate the change in consumer surplus of any counterfactual policy by $CS_t(p_t) - CS_t(p_t^*)$ for the new equilibrium.

In practice, we considered several counterfactual policy experiments consisting in changing the ownership of products. In particular, we take advantage of the introduction of the strategic effect of retailers' behavior in the vertical relationship with manufacturers to simulate policies where ownership of private labels changes from retailers to some manufacturer.

Table 10 shows the results of the simulations of policies consisting in allocating the brand ownership of all private labels to one of the three manufacturers while the pricing policy of manufacturers continues using two part tariffs contracts with resale price maintenance. Giving all private labels to Danone or Nestlé results in an increase of the average price of bottles of water of a little more than 1% and a decrease of market shares between 7 and 12% on average. The increase in average prices is also on average larger for the private labels that passed to the manufacturer. Giving the private labels to Castel would result in a larger increase of the average price of these private labels and an increase of prices of products of Castel that would use its increased market power to increase prices of all its products that are more substitute with private labels than those of other national brands. Moreover, all these policies would decrease the consumer surplus which means that on this very concentrated market, private labels are actually beneficial to consumers.

Policy	Change of price p^*_{jt}	Change in market share s^*_{jt}
Private Labels to Danone		
Average[19]	+1.34 %	-12.28 %
Average for Danone PL	+2.26 %	-18.88 %
Average for Danone NB	+0.92 %	-15.38 %
Average for Nestlé	+0.28 %	-7.96 %
Average for Castel	+4.23 %	-8.58 %
Average for outside good		+4.98 %
$\frac{CS_t(p^*_t)-CS_t(p_t)}{CS_t(p_t)}$ in %	-39.85 %	
Private Labels to Nestlé		
Average	+1.17 %	-7.32 %
Average for Danone	+1.11 %	-13.97 %
Average for Nestlé PL	+3.17 %	-13.26 %
Average for Nestlé NB	+0.37 %	-2.47 %
Average for Castel	+1.12 %	+0.49 %
Average for outside good		+2.86 %
$\frac{CS_t(p^*_t)-CS_t(p_t)}{CS_t(p_t)}$ in %	-25.66 %	
Private Labels to Castel		
Average	+2.42 %	-21.18 %
Average for Danone	+1.21 %	-28.96 %
Average for Nestlé	+1.23 %	-24.47 %
Average for Castel PL	+1.24 %	+0.58 %
Average for Castel NB	+9.62 %	-2.54 %
Average for outside good		+8.69 %
$\frac{CS_t(p_t)-CS_t(p^*_t)}{CS_t(p_t)}$ in %	-34.17 %	

Table 10 : Policy experiments on Private Labels Ownership

6 Conclusion

In this paper, we presented the first empirical estimation of a structural model taking into account explicitly two part tariffs contracts between manufacturers and retailers. We show how to estimate different structural models embedding the strategic relationships between manufacturers and retailers in the supermarket industry. In particular, we presented how one can test whether manufacturers use two part tariffs contracts with retailers. We consider several alternative models of competition between manufacturers and retailers on a differentiated product market and test between these alternatives. We consider in particular two types of non linear pricing relationships with two part tariffs contracts, where in one resale price maintenance is used and in the other no resale price maintenance

[19] The average is over the periods (39) and products (54).

is allowed. The method is based on estimates of demand parameters that allow to recover price-cost margins at the manufacturer and retailer levels. We then test between the different models using exogenous variables that are supposed to shift the marginal cost of production and distribution. We apply this methodology to study the market for retailing bottled water in France. Our empirical evidence allows to conclude that manufacturers and retailers use non linear pricing contracts and in particular two part tariffs contracts with resale price maintenance. Although resale price maintenance is illegal in France, our empirical result just shows that contractual relationships imply pricing strategies that allow to replicate this equilibrium. But it is worth noting that this pricing equilibrium could be reached through the use of two part tariffs contracts with resale price maintenance, but it is possible that it is in reality implemented through more complex non linear contracts that would not involve resale price maintenance. Finally, we were able to simulate some counterfactual policy experiments related to the non linear pricing mechanisms used by manufacturers and retailers.

This work calls for further developments and studies about competition under non linear pricing in the supermarket industry. In particular, we need further studies where assumptions of non constant marginal cost of production and distribution would be allowed are needed. Also, it is clear that more empirical work on other markets will be useful for a better understanding of vertical relationships in the retailing industry. Finally taking into account the endogenous market structure is also an objective that theoretical and empirical research will have to tackle.

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7 Appendix

7.1 Detailed proof of the manufacturers profit expression under two part tariffs

We use the theoretical results due to Rey and Vergé (2004) applied to our context with F firms and R retailers. The participation constraint being binding, we have for all r $\sum_{s\in S_r}[M(p_s-w_s-c_s)s_s(p)-F_s]=0$ which implies that

$$\sum_{s\in S_r} F_s = \sum_{s\in S_r} M(p_s-w_s-c_s)s_s(p)$$

and thus

$$\begin{aligned}\sum_{j\in F_f} F_j + \sum_{j\notin F_f} F_j &= \sum_{j=1,.,J} F_j = \sum_{r=1,.,R}\sum_{s\in S_r} F_s \\ &= \sum_{r=1,.,R}\sum_{s\in S_r} M(p_s-w_s-c_s)s_s(p) = \sum_{j=1,.,J} M(p_j-w_j-c_j)s_j(p)\end{aligned}$$

so that

$$\sum_{j\in F_f} F_j = \sum_{j=1,..,J} M(p_j-w_j-c_j)s_j(p) - \sum_{j\notin F_f} F_j$$

Then, the firm f profits are

$$\begin{aligned}\Pi^f &= \sum_{k\in F_f} M(w_k-\mu_k)s_k(p) + \sum_{k\in F_f} F_k \\ &= \sum_{k\in F_f} M(w_k-\mu_k)s_k(p) + \sum_{j=1,..,J} M(p_j-w_j-c_j)s_j(p) - \sum_{j\notin F_f} F_j\end{aligned}$$

Since, producers fix the fixed fees given the ones of other producers, we have that under resale price maintenance :

$$\begin{aligned}\max_{\{F_i,p_i\}_{i\in F_f}} \Pi^f &\Leftrightarrow \max_{\{p_i\}_{i\in F_f}} \sum_{k\in F_f} (w_k-\mu_k)s_k(p) + \sum_{j=1,..,J} (p_j-w_j-c_j)s_j(p) \\ &\Leftrightarrow \max_{\{p_i\}_{i\in F_f}} \sum_{k\in F_f} (p_k-\mu_k)s_k(p) + \sum_{k\notin F_f} (p_k-w_k-c_k)s_k(p)\end{aligned}$$

and with no resale price maintenance

$$\begin{aligned}\max_{\{F_i,w_i\}_{i\in F_f}} \Pi^f &\Leftrightarrow \max_{\{w_i\}_{i\in F_f}} \sum_{k\in F_f} (w_k-\mu_k)s_k(p) + \sum_{j=1,..,J} (p_j-w_j-c_j)s_j(p) \\ &\Leftrightarrow \max_{\{w_i\}_{i\in F_f}} \sum_{k\in F_f} (p_k-\mu_k)s_k(p) + \sum_{k\notin F_f} (p_k-w_k-c_k)s_k(p)\end{aligned}$$

Then the first order conditions of the different two part tariffs models can be derived very simply.

7.2 Detailed resolution of system of equations

Generically we have systems of equations to be solved of the form

$$\begin{cases} A_f(\gamma+\Gamma)+B_f=0 \\ \text{for } f=1,..,G \end{cases}$$

where A_f and B_f are some given matrices.

Solving this system amounts to solve the following minimization problem

$$\min_{\gamma+\Gamma}\sum_{f=1}^{G}\left[A_f(\gamma+\Gamma)+B_f\right]'\left[A_f(\gamma+\Gamma)+B_f\right]$$

leads to the first order conditions

$$\left(\sum_{f=1}^{G}A_f'A_f\right)(\gamma+\Gamma)-\sum_{f=1}^{G}A_f'B_f=0$$

that allow to find the following expression for its solution

$$(\gamma+\Gamma)=\left(\sum_{f=1}^{G}A_f'A_f\right)^{-1}\sum_{f=1}^{G}A_f'B_f$$

7.3 Structural demand equation and instruments

The structural demand model is such that

$$\begin{aligned} \ln s_{jt}-\ln s_{0t} &= \theta_{jt}+\sigma_g\ln s_{jt|g}+u_{jt} \\ \ln s_{jt}-\ln s_{0t} &= \delta_j+\gamma_t-\alpha p_{jt}+\sigma_g\ln s_{jt|g}+u_{jt} \end{aligned}$$

where $s_{jt|g}$ is endogenous because $E\left(s_{jt|g}.u_{jt}\right)\neq 0$. Taking the log of the expression of the relative market share of good j in group g, we have

$$\ln s_{jt-1/g}=\frac{\theta_{jt-1}+u_{jt-1}}{1-\sigma_g}-\ln\left[\sum_{j\in J_g}\exp\frac{\theta_{jt-1}+u_{jt-1}}{1-\sigma_g}\right]$$

Then, with a first order approximation gives

$$\ln\left[\sum_{j\in J_g}\exp\frac{\theta_{jt-1}+u_{jt-1}}{1-\sigma_g}\right]\simeq\frac{\theta_{j^*t-1}+u_{j^*t-1}}{1-\sigma_g}$$

where j^* is such that $\theta_{j^*t-1}+u_{j^*t-1}>\theta_{jt-1}+u_{jt-1}\ \forall j\neq j^*$. Then,

$$\ln s_{jt-1/g}\simeq\frac{\theta_{jt-1}+u_{jt-1}}{1-\sigma_g}-\frac{\theta_{j^*t-1}+u_{j^*t-1}}{1-\sigma_g}$$

Then,

$$\begin{aligned}
\varsigma_{jt-1} &= \ln s_{jt-1/g} - E\left(\ln s_{jt-1/g} | \left\{\theta_{jt-1}\right\}_{j=1,..,J}\right) \\
&\simeq \frac{u_{jt-1}}{1-\sigma_g} + E\left(\frac{\theta_{j^*t-1} + u_{j^*t-1}}{1-\sigma_g} | \left\{\theta_{jt-1}\right\}_{j=1,..,J}\right) - \frac{\theta_{j^*t-1} + u_{j^*t-1}}{1-\sigma_g} \\
&\simeq \frac{u_{jt-1} - u_{j^*t-1}}{1-\sigma_g}
\end{aligned}$$

Thus, assuming that $\forall j \neq j', \forall t$, $E\left(u_{j't}.u_{jt-1}\right) = 0$ it implies that $E\left(u_{j't}.\varsigma_{jt-1}\right) \simeq 0$ which justifies the use of ς_{jt-1} in the list of instruments Z_t.

7.4 Identification method of demand and supply parameters

Under a given supply model, for a given product j, at period t, the total price cost margins $\gamma_{jt} + \Gamma_{jt}$ can be expressed as a parametric function of prices and unobserved demand shocks $u_t = (u_{1t}, .., u_{jt}, .., u_{Jt})$: in the case of two part tariffs with resale price maintenance,

$$\gamma_{jt} + \Gamma_{jt} = -\left[(I_f S_{p_t} I_f)^{-1} I_f s(p_t, u_t)\right]_j$$

where $[.]_j$ denotes the j^{th} row of vector $[.]$.

As marginal cost can be expressed as a function of observed cost shifter W_{jt}, unobserved product specific effects ω_j, and unobserved shocks η_{jt}, we have

$$C_{jt} = \exp(\omega_j + W'_{jt}\lambda)\eta_{jt}$$

The identification of the price-cost margins relies on the assumption that instruments Z_{jt} satisfy

$$E\left(Z_{jt} u_{jt}\right) = 0$$

and the identification of the cost function relies on the assumption that

$$E(\ln \eta_{jt} W_{jt}) = E(\ln \eta_{jt} \omega_j) = 0$$

However, adding cost and marginal cost equations, one can also get a price equation

$$p_{jt} + \left[(I_f S_{p_t} I_f)^{-1} I_f s(p_t, u_t)\right]_j = \exp(\omega_j + W'_{jt}\lambda)\eta_{jt}$$

Identifying the parameters of this price equation would then require the specification of the joint law of unobservable shocks $\left(\eta_{jt}, u_t\right)$. Thus, our two-step method has the advantage of providing identification of demand and cost parameters under weaker assumptions. In particular we do not have to make any assumptions on the correlation between unobserved shocks (η_{jt}, u_t).

7.5 Details on regressions for demand estimates

Our first stage regressions for the two stage least squares estimation are

$$\begin{aligned} \ln s_{jt|g} &= Z_{jt}\beta^g + \xi_{jt}^g \text{ for } g = 1,2 \\ p_{jt} &= Z_{jt}\beta^p + \xi_{jt}^p \end{aligned}$$

that are presented in Table 11.

First stage regressions	Dependent Variable		
Explanatory variables Z_{jt}	Price p_{jt}	$\ln s_{jt\|g}$ (Spring)	$\ln s_{jt\|g}$ (Mineral)
z_{jt}			
(wage) $w_t^1 \times 1_{(j\in Mineral)}$	0.00757 (0.0243)	-0.0186 (0.0252)	-1.36e-14 (0.039)
(wage) $w_t^1 \times 1_{(j\in Spring)}$	0.0533 (0.0285)	0.0186 (0.0295)	0.0265 (0.0461)
(plastic) $w_t^2 \times 1_{(j\in Mineral)}$	0.00453 (0.01)	-0.0178 (0.0104)	-6.51e-15 (0.016)
(plastic) $w_t^2 \times 1_{(j\in Spring)}$	0.00129 (0.0117)	0.0178 (0.0121)	0.0165 (0.0189)
(diesel) $w_t^3 \times 1_{(j\in Mineral)}$	-0.00317 (0.0048)	0.00907 (0.0049)	8.66e-15 (0.0077)
(diesel) $w_t^3 \times 1_{(j\in Spring)}$	0.00149 (0.0056)	-0.00907 (0.0058)	0.0027 (0.00909)
(oil) $w_t^4 \times 1_{(j\in Mineral)}$	0.00671 (0.0061)	-0.0121 (0.00635)	-1.06e-14 (0.010)
(oil) $w_t^4 \times 1_{(j\in Spring)}$	-0.00551 (0.0071)	0.0121 (0.00743)	-0.00293 (0.0116)
(packaging) $w_t^5 \times 1_{(j\in Mineral)}$	-0.00185 (0.0070)	0.00571 (0.0073)	-1.45e-15 (0.011)
(packaging) $w_t^5 \times 1_{(j\in Spring)}$	-0.00618 (0.0082)	-0.00571 (0.0085)	-0.0111 (0.0133)
ς_{jt-1} (mineral water)	-0.0471 (0.0279)	0.535 (.0289)	2.65e-15 (0.045)
ς_{jt-1} (spring water)	0.0311 (0.0328)	-0.535 (.034)	0.209 (0.053)
Product fixed effects not shown			
$F(53, 1808)$ test, (p-value)	122.18 (0.00)	298.30 (0.00)	202.06 (0.00)

Table 11 : First Stage Regressions for the Demand Estimation

7.6 Estimates of cost equations

Here, we present the empirical results of the estimation of the cost equation (19) for $h = 1, ..., 14$ that is

$$\ln C_{jt}^h = \omega_j^h + W_{jt}\lambda_g + \ln \eta_{jt}^h$$

where variables W_{jt} include time dummies δ_t, wages, oil, diesel, packaging material and plastic price variables interacted with the dummy variable for spring water (SW) and mineral water (MW).

$\ln C_{jt}^h$	Coefficients (Std. err.) salary$\times SW$	salary$\times MW$	plastic$\times SW$	plastic$\times MW$	packaging$\times SW$	packaging$\times MW$
Model 1	-0.316 (0.032)	-0.109 (0.025)	-0.074 (0.014)	-0.039 (0.012)	0.071 (0.011)	0.020 (0.009)
Model 2	-0.504 (0.042)	-0.147 (0.032)	-0.127 (0.018)	-0.054 (0.015)	0.098 (0.014)	0.030 (0.012)
Model 3	-0.318 (0.041)	-0.110 (0.030)	-0.062 (0.018)	-0.037 (0.014)	0.063 (0.013)	0.026 (0.011)
Model 4	0.040 (0.058)	-0.175 (0.040)	0.090 (0.024)	-0.055 (0.019)	0.000 (0.017)	0.039 (0.014)
Model 5	-0.021 (0.015)	-0.008 (0.012)	0.001 (0.007)	-0.009 (0.006)	0.002 (0.005)	0.006 (0.004)
Model 6	-0.036 (0.015)	-0.009 (0.012)	-0.001 (0.007)	-0.010 (0.006)	0.005 (0.005)	0.006 (0.004)
Model 7	-0.107 (0.018)	-0.042 (0.014)	-0.020 (0.008)	-0.020 (0.007)	0.020 (0.006)	0.013 (0.005)
Model 8	-0.165 (0.021)	-0.057 (0.017)	-0.035 (0.009)	-0.024 (0.008)	0.034 (0.007)	0.014 (0.006)
Model 9	0.002 (0.013)	0.008 (0.010)	0.005 (0.006)	-0.004 (0.005)	-0.002 (0.004)	0.003 (0.004)
Model 10	-0.019 (0.014)	-0.008 (0.011)	0.001 (0.006)	-0.008 (0.005)	0.003 (0.005)	0.006 (0.004)
Model 11	-0.007 (0.013)	-0.002 (0.011)	0.003 (0.006)	-0.006 (0.005)	-0.000 (0.005)	0.004 (0.004)
Model 12	-0.076 (0.014)	-0.040 (0.011)	-0.014 (0.006)	-0.017 (0.005)	0.014 (0.005)	0.012 (0.004)
Model 13	-0.027 (0.014)	-0.011 (0.011)	-0.000 (0.006)	-0.007 (0.005)	0.004 (0.005)	0.006 (0.004)
Model 14	-0.133 (0.015)	-0.066 (0.012)	-0.027 (0.007)	-0.024 (0.006)	0.025 (0.005)	0.016 (0.004)

Table 12 : Cost Equations for the Multinomial Logit Model

$\ln C_{jt}^h$	Coefficients (Std. err.) diesel$\times SW$	diesel$\times MW$	oil$\times SW$	oil$\times MW$	All $\delta_t = 0$ F test (p val.)	All $\omega_j^g = 0$ F test (p val.)
Model 1	-0.013 (0.007)	0.006 (0.006)	0.040 (0.009)	0.007 (0.008)	8.01 (0.000)	274.39 (0.000)
Model 2	-0.003 (0.009)	0.007 (0.007)	0.043 (0.012)	0.008 (0.010)	5.80 (0.000)	189.82 (0.000)
Model 3	-0.027 (0.008)	0.004 (0.006)	0.058 (0.011)	0.008 (0.009)	3.35 (0.000)	250.34 (0.000)
Model 4	-0.061 (0.012)	-0.004 (0.009)	0.058 (0.015)	0.024 (0.013)	2.08 (0.001)	218.02 (0.000)
Model 5	-0.005 (0.003)	-0.000 (0.003)	0.011 (0.005)	0.003 (0.004)	1.67 (0.011)	783.26 (0.000)
Model 6	-0.005 (0.003)	-0.000 (0.003)	0.012 (0.005)	0.003 (0.004)	1.72 (0.008)	796.10 (0.000)
Model 7	-0.006 (0.004)	0.001 (0.003)	0.018 (0.005)	0.004 (0.005)	2.64 (0.000)	729.80 (0.000)
Model 8	-0.009 (0.004)	0.003 (0.004)	0.024 (0.006)	0.004 (0.005)	3.47 (0.000)	599.76 (0.000)
Model 9	-0.004 (0.003)	-0.001 (0.003)	0.007 (0.004)	0.002 (0.003)	1.29 (0.133)	560.97 (0.000)
Model 10	-0.005 (0.003)	-0.000(0.002)	0.010 (0.004)	0.002 (0.004)	1.16 (0.251)	535.56 (0.000)
Model 11	-0.004 (0.003)	-0.001 (0.002)	0.008 (0.004)	0.002 (0.003)	1.47 (0.045)	557.61 (0.000)
Model 12	-0.005 (0.003)	0.001 (0.002)	0.014 (0.004)	0.004 (0.004)	3.43 (0.000)	550.13 (0.000)
Model 13	-0.005 (0.003)	-0.001 (0.002)	0.012 (0.004)	0.004 (0.003)	1.89 (0.002)	562.73 (0.000)
Model 14	-0.005 (0.003)	0.001 (0.003)	0.020 (0.004)	0.007 (0.004)	7.25 (0.000)	519.31 (0.000)

Table 12 (continued) : Cost Equations for the Multinomial Logit Model

$\ln C_{jt}^h$	Coefficients (Std. err.) salary$\times SW$	salary$\times MW$	plastic$\times SW$	plastic$\times MW$	packaging$\times SW$	packaging$\times MW$
Model 1	-0.172 (0.023)	-0.006 (0.018)	-0.010 (0.010)	0.000 (0.008)	-0.004 (0.010)	-0.025 (0.009)
Model 2	-0.206 (0.025)	-0.005 (0.020)	-0.017 (0.011)	-0.000 (0.008)	-0.003 (0.011)	-0.028 (0.010)
Model 3	-0.257 (0.028)	-0.010 (0.022)	-0.029 (0.012)	-0.000 (0.009)	-0.003 (0.012)	-0.035 (0.010)
Model 4	0.027 (0.036)	-0.046 (0.025)	0.062 (0.014)	-0.003 (0.011)	-0.037 (0.014)	-0.024 (0.012)
Model 5	-0.007 (0.013)	0.004 (0.010)	0.011 (0.006)	0.000 (0.004)	-0.003 (0.006)	0.000 (0.005)
Model 6	-0.006 (0.019)	0.004 (0.015)	0.017 (0.008)	-0.003 (0.006)	-0.010 (0.0081)	0.002 (0.007)
Model 7	-0.015 (0.014)	-0.002 (0.011)	0.010 (0.006)	0.001 (0.005)	-0.005 (0.006)	-0.002 (0.005)
Model 8	-0.018 (0.016)	0.012 (0.013)	0.011 (0.007)	0.006 (0.005)	-0.005 (0.007)	-0.005 (0.006)
Model 9	0.000 (0.012)	0.005 (0.010)	0.008 (0.005)	-0.001 (0.004)	-0.001 (0.005)	0.002 (0.005)
Model 10	-0.004 (0.014)	-0.006 (0.011)	0.005 (0.006)	-0.004 (0.005)	0.001 (0.006)	0.006 (0.005)
Model 11	-0.003 (0.012)	0.004 (0.010)	0.009 (0.005)	0.000 (0.004)	-0.003 (0.005)	0.001 (0.005)
Model 12	-0.031 (0.015)	-0.007 (0.011)	0.006 (0.006)	-0.001 (0.005)	-0.005 (0.006)	-0.004 (0.006)
Model 13	-0.008 (0.013)	0.002 (0.011)	0.010 (0.006)	0.000 (0.004)	-0.000 (0.006)	0.001 (0.005)
Model 14	-0.097(0.018)	-0.008 (0.014)	0.001 (0.007)	0.003 (0.006)	-0.006 (0.007)	-0.019 (0.007)

Table 13 : Cost Equations for the Nested Logit Model

	Coefficients (Std. err.)				All $\delta_t = 0$	All $\omega_j^g = 0$
$\ln C_{jt}^h$	diesel$\times SW$	diesel$\times MW$	oil$\times SW$	oil$\times MW$	F test (p val.)	F test (p val.)
Model 1	0.013 (0.005)	0.014 (0.004)	0.000 (0.007)	-0.010 (0.006)	5.38 (0.000)	300.63 (0.000)
Model 2	0.017 (0.005)	0.016 (0.005)	-0.001 (0.008)	-0.013 (0.006)	5.48 (0.000)	274.99 (0.000)
Model 3	0.024 (0.006)	0.020 (0.005)	-0.005 (0.008)	-0.016 (0.007)	6.01 (0.000)	244.69 (0.000)
Model 4	-0.010 (0.008)	0.015 (0.006)	0.007 (0.010)	-0.006 (0.008)	3.13 (0.000)	233.37 (0.000)
Model 5	-0.002 (0.003)	-0.001 (0.002)	0.005 (0.004)	0.003 (0.003)	1.09 (0.345)	495.72 (0.000)
Model 6	-0.001 (0.004)	-0.001 (0.003)	0.006 (0.006)	0.002 (0.005)	1.02 (0.435)	276.84(0.000)
Model 7	-0.000 (0.003)	0.001 (0.003)	0.004 (0.004)	0.002 (0.004)	1.21 (0.200)	473.69 (0.000)
Model 8	0.001 (0.004)	-0.000 (0.003)	0.002 (0.005)	0.002 (0.004)	1.23 (0.190)	383.82 (0.000)
Model 9	-0.003 (0.003)	0.002 (0.002)	0.006 (0.004)	0.003 (0.003)	1.08 (0.356)	473.31 (0.000)
Model 10	-0.005 (0.003)	-0.002 (0.003)	0.008 (0.004)	0.003 (0.004)	0.84 (0.707)	236.63 (0.000)
Model 11	-0.002 (0.003)	-0.001 (0.002)	0.005 (0.004)	0.003 (0.003)	1.13 (0.287)	490.63 (0.000)
Model 12	-0.000 (0.003)	0.002 (0.003)	0.002 (0.003)	0.006 (0.004)	1.97 (0.002)	298.09 (0.000)
Model 13	-0.004 (0.003)	-0.001 (0.003)	0.007 (0.004)	0.003 (0.003)	1.18 (0.238)	452.71 (0.000)
Model 14	0.006 (0.004)	0.009 (0.003)	0.006 (0.005)	-0.006 (0.005)	6.33 (0.000)	350.49 (0.000)

Table 13 (continued) : Cost Equations for the Nested Logit Model

7.7 Additional non nested tests

Vuong (1989) Test Statistic											
$\diagdown$	H_2										
H_1	2	3	4	5	6	7	8	9	10	11	12
1	3.74	3.34	8.01	-4.96	-4.93	-4.10	-2.78	-5.396	-6.02	-5.62	-5.64
2		1.70	5.77	-7.10	-7.16	-6.32	-4.93	-7.67	-8.23	-7.82	-7.84
3			6.46	-7.01	-7.08	-6.17	-5.74	-7.52	-8.21	-7.77	-7.78
4				-12.93	-13.16	-11.84	-11.38	-13.54	-14.51	-13.89	-13.90
5					0.56	13.18	4.39	-2.03	-12.23	-7.81	-9.29
6						7.77	4.92	-2.58	-11.29	-7.07	-6.67
7							2.51	-11.99	-15.53	-13.27	-14.69
8								-5.06	-6.58	-5.77	-5.67
9									-12.00	-7.30	-7.23
10										14.26	12.21
11											0.46

Table 14 : Results of the Vuong Test for the Multinomial Logit Model

Vuong (1989) Test Statistic											
$\diagdown$	H_2										
H_1	2	3	4	5	6	7	8	**9**	10	11	12
1	9.17	7.68	7.98	-15.49	-1.06	-14.98	-3.95	-15.35	-15.65	-11.21	-13.57
2		6.64	6.88	-15.46	-1.39	-14.96	-4.62	-14.65	-15.78	-11.70	-13.98
3			5.46	-14.46	-1.79	-13.96	-5.32	-12.57	-14.98	-11.56	-13.47
4				-14.94	-2.44	-14.55	-6.55	-12.10	-15.30	-12.35	-14.54
5					1.58	12.88	2.09	12.51	-11.47	5.49	0.47
6						-1.35	-0.64	-0.27	-1.91	-1.13	-1.54
7							1.56	11.04	-12.97	2.49	-2.15
8								0.98	-2.85	-1.02	-1.96
9									-13.55	-7.40	-9.59
10										10.86	4.56
11											-3.63

Table 15 : Results of the Vuong Test for the Nested Logit Model

7.8 Formulas

Price elasticity of product j market share with respect to price of product k :

$$\eta_{jk} \equiv \frac{\partial s_j}{\partial p_k}\frac{p_k}{s_j} = \begin{cases} \frac{\alpha}{1-\sigma_g} p_k[\sigma_g s_{j/g} + (1-\sigma_g)s_j - 1] & \text{if } j = k \text{ and } \{j,k\} \in g \\ \frac{\alpha}{1-\sigma_g} p_k[\sigma_g s_{k/g} + (1-\sigma_g)s_k] & \text{if } j \neq k \text{ and } \{j,k\} \in g \\ \alpha p_k s_k & \text{if } j \in g \text{ and } k \in g\prime \text{ and } g \neq g' \end{cases}$$

Price elasticities of group g market share with respect to product k :

$$\eta_{gk} \equiv \frac{\partial s_g}{\partial p_k}\frac{p_k}{s_g} == \begin{cases} \alpha p_k s_{g'} s_{k/g'} & if \text{ k} \in g' \text{ and } g \neq g' \\ \alpha p_k s_{k/g}(s_g - 1) & if \text{ k} \in g \end{cases}$$

Price elasticities of firm f manufacturer's total market share with respect to product k :

$$\eta_{fk} \equiv \frac{\partial s_f}{\partial p_k}\frac{p_k}{s_f} = \begin{cases} \frac{\alpha}{1-\sigma_g} p_k[\sigma_g s_{k/g} + (1-\sigma_g)s_k] - \frac{\alpha}{1-\sigma_g}\frac{s_k}{s_{F_f}} p_k & \text{if } k \in F_f \\ \frac{\alpha}{1-\sigma_g} p_k[\sigma_g s_{k/g} + (1-\sigma_g)s_k] & \text{if } k \notin F_f \text{ and } \{F_f, k\} \in g \\ \alpha p_k s_k & \text{if } k \notin F_f \text{ and } F_f \in g \text{ and } k \in g' \end{cases}$$