Inference on Vertical Contracts between Manufacturers and Retailers Allowing for Nonlinear Pricing and Resale Price Maintenance

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Abstract

A methodology is presented allowing manufacturers and retailers vertical contracting in their pricing strategies on a differentiated product market to be introduced. This contribution allows price-cost margins to be recovered from estimates of demand parameters both under linear pricing models and two part tariffs. Two types of nonlinear 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 tariff contracts in particular are considered. The methodology then allows different hypotheses on contracting and pricing relationships between manufacturers and retailers in the supermarket industry to be tested using exogenous variables supposed to shift the marginal costs of production and distribution. This method is applied empirically to study the retail market bottled water in France. Our empirical evidence shows that manufacturers and retailers use nonlinear pricing contracts and in particular two part tariff contracts with resale price maintenance. Finally, using the estimation of our structural model, some simulations of counterfactual policy experiments are introduced.

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

JEL codes: L13, L81, C12, C33

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1 Introduction

Vertical relationships between manufacturers and retailers seem to be becoming even more prevalent in the supermarket industry, especially in food retailing. Competition analysis and issues related to market power on some consumer 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 extent of competition among manufacturers and retailers. The aim of this paper is thus to develop a methodology allowing alternative structural models to be assessed, where the role of manufacturers and retailers is explicit in the horizontal and vertical strategic behaviors. Previous work on these issues does not generally account for the behavior of retailers in manufacturers' pricing strategies. One of the reasons for this 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 price-cost margins that are necessary for market power analysis and policy simulations to be estimated, 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 product markets (see, for example, Bresnahan 1987, 1989, 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 significant influence distributors have on prices through the use of data on wholesale and retail prices. The strategic role of retailers has been emphasized only recently in empirical economic and marketing literature.

Goldberg and Verboven (2001), Manuszak (2001), Mortimer (2004), Sudhir (2001), Berto Villas Boas (2007) or Villas-Boas and Zhao (2005) introduce retailers' strategic behavior. Manuszak (2001) studies the impact of upstream mergers on retail gasoline markets using a structural model allowing downstream prices to be related to upstream mark-ups and wholesale prices chosen by upstream gasoline refineries. Asker (2004) studies exclusive dealing in the beer market. Hellerstein (2004) explains imperfect pass-through again in the beer market. Among the few papers that take into account vertical relationships, Ho (2006) studies the welfare effects of vertical contracting between hospitals and Health Maintenance Organizations in the US. Ho (2008) studies how managed care health insurers restrict their enrollees' choice of hospitals to specific networks using the inequality framework of Pakes, Porter, Ho and Ishii (2006) for identification. In the retail industry, Sudhir (2001) considers 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 mostly consider cases where competition between producers and/or retailers remains under linear pricing. Berto Villas-Boas (2007) extends 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 alternatively setting wholesale margins or retail margins to zero.

Our work contributes to this literature by showing a way to include nonlinear pricing (two part tariffs and resale price maintenance) in the theoretical model with retailers and manufacturers, as well as showing how to identify such models empirically, make inferences and policy simulations under limited data on wholesale prices and on two part tariffs, the latter providing the data context for most studies on these issues. A method to test across different hypothesis on the strategic relationships between manufacturers and retailers in the supermarket industry competing on a differentiated product market is then presented. In particular, following Rey and Vergé (2004), two types of nonlinear pricing relationships are considered, one where resale price maintenance is used with two part tariff contracts and one where no resale price maintenance is allowed. Modelling explicitly optimal two part tariff contracts (with or without resale price maintenance) allows the pricing strategy of manufacturers and retailers to be identified and thus total price-cost margins as functions of demand parameters without observing wholesale prices. Using non-nested test procedures, it is shown how to test between the different models using exogenous variables that shift the marginal costs of production and distribution.

This methodology is applied to study the market for retailing bottled water in France and present the first formal empirical tests of such a model including nonlinear contracts between manufacturers and retailers. This market shows a high degree of concentration both at the manufacturer and retailer levels. It should be noted that this is actually even more concentrated at the manufacturer level. Our empirical evidence shows that, in the French bottled water market, manufacturers and retailers use nonlinear pricing contracts and in particular two part tariff contracts with resale price maintenance. Finally it is also shown how to simulate different counterfactual policies using a structural model as with a de-merger between Perrier and Nestlé, a double marginalization case and a nonlinear relationship between manufacturers and retailers without resale price maintenance.

In section 2, some stylized facts on the market for bottled water in France are given, this being 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. It is shown how price-cost margins can be recovered with demand parameters, in particular when taking explicitly into account two part tariff 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 sectors of the French food processing industry: the total production of bottled water increased by 4% in 2000, and its revenues 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 highly concentrated, the first three main manufacturers (Nestlé Waters, Danone, and Castel) sharing 90% of total production for the sector. Moreover, given the scarcity of natural springs, entry onto the mineral or spring water market is difficult. Compte, Jenny and Rey (2002) comment on the Nestlé/Perrier Merger case that took place in 1992 in Europe and point out that in addition to the high concentration of the sector, these capacity constraints are a factor for collusion. The sector can be divided in two major segments: mineral water and spring water. Natural mineral water benefits from 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, appearance, and taste. Mineral water can be marketed if it receives a certification from the French Ministry of Health. Exploitation of a spring water source requires only a license provided by the authorities (*Prefectures*) and approved from the local health administration. Moreover, composition of the water is not required to be constant. Differences between the quality requirements involved in certification of the two kinds of bottled water may explain part of the substantial difference that exists between the shelf prices of national mineral water brands and local spring water brands. Moreover, national mineral water brands are highly advertised. Bottled water products mainly use 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. At present, thanks to data at the aggregate level (Agreste, 1999, 2000, 2002) on food industries and the bottled water industry, it can be seen (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 of 6.8% over the 1998-2001 period. By comparison, the highest advertising to revenue ratio in the US food processing industry corresponds to the ready-to-eat breakfast cereals industry and stands at 10.8%. These figures may be interpreted as showing the significance 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 some accounting price-cost margins[1] defined as value added[2] (VA) minus payroll (PR) and advertising expenses (AD) divided by the value of shipments (TR) to be computed. As stressed by Nevo (2001), these accounting estimates can be considered as an upper bound to the true price-cost margins.

Recently, degradation of the tap water distribution network has led to an increase in bottled water consumption. This increase benefited the cheapest bottled water, that is, local spring water. For instance, the total volume of local spring water sold in 2000 approached the total volume of mineral water sold the same year. Households buy bottled water mostly in supermarkets, representing 80% of the total sales of bottled water. 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 mainly deal their brands through retail chains. These chains are also highly concentrated, the market share of the first five accounting for 80.7% of total food product sales. Moreover, over the last few years, as in other processed food products, these chains have developed their own private labels to attract consumers. The increase in the number of such private labels tends to be accompanied by a reduction in the market share of the main national brands.

We thus face a relatively concentrated market where 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

[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.

for consumer welfare, has then to take into account the possibility that nonlinear pricing may be used between manufacturers and retailers. As a rule, two part tariffs are relatively simple contracts that may allow manufacturers to benefit from their bargaining position in selling national brands. Therefore, the next section studies different alternative models of strategic relationships between multiple manufacturers and multiple retailers worthy of consideration.

3 Competition and Vertical Relationships Between Manufacturers and Retailers

Before presenting our demand model, modelling of competition and vertical relationships between manufacturers and retailers is presented. Given the structure of the bottled water industry and the retail industry in France, several oligopoly models with different vertical relationships are considered. More precisely, it is shown how each supply model can be solved to obtain an expression for both the retailer's and manufacturer's price-cost margins as a function of demand side parameters. Then using estimates of a differentiated products demand model, these price-cost margins can be estimated empirically and it will be shown how these competing scenarios can be tested. A similar methodology has already been used for double marginalization scenarios considered below by Sudhir (2001) or Brenkers and Verboven (2006) or Berto Villas-Boas (2007) but none of the papers in this literature have addressed the particular case of competition in two part tariffs using the recent theoretical insights of Rey and Vergé (2004).

Notations will be as follows. There are J differentiated products defined by the brand-retailer couple corresponding to J' national brands and $J-J'$ private labels. It is assumed there are R retailers competing in the retail market and F manufacturers competing in the wholesale market. S_r denotes the set of products sold by retailer r and G_f the set of products produced by firm f. In the following we successively present the different oligopoly models to be studied. Remark that the set of products and their ownership will be considered as being exogenous to our model, such that all ownership matrices defined are exogenous. A next step in this research would be to endogenize the set of products, brand ownership by manufacturers and the retailers choice of brand variety.

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 though conducting both manufacturing and retailing. Competition is considered *à la* Nash-Bertrand. This vertical model is solved by backward induction considering the retailer's problem first. The profit Π^r of retailer r in a given period (the time subscript t is dropped 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 product's retail prices and M is the size of the market (including the outside good). 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, I_r is defined as the $(J \times J)$ ownership matrix of the retailer r that is diagonal and whose element $I_r(j,j)$ is equal to one if retailer r sells product j and zero otherwise. Let S_p be the market share response matrix to retailer prices, containing the first derivatives of all market shares with respect to all retail prices, i.e.

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

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 replacing the wholesale price w by the marginal cost of production μ in this formula.

Concerning the manufacturers' behavior, it is also assumed that each of them maximizes 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

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

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

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

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. 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, is introduced.

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

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

The first order conditions (3) can then be expressed in matrix form and the vector of manufacturer's margins is[4]

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

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

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

The first derivatives of retail prices with respect to wholesale prices depend on the strategic interactions between manufacturers and retailers. Let us assume that manufacturers set the wholesale prices and retailers follow, setting retail prices in relation to 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]:

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

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 substituting the expression (6) for P_w in (4).

The expression (6) derives from the assumption that manufacturers act as Stackelberg leaders in the vertical relationships with retailers. In the case where we assume that retailers and manufacturers set their prices simultaneously, we can infer like Sudhir (2001) that only the direct effect of wholesale price on retail price matter through the change in the marginal cost of products for the retailer. Thus, the retailer's cost of input is accounted for in the retailer's choice of margin. Both the manufacturer and retailer take the retail price as given and play a Nash game in margins. In this case, the matrix P_w has to be

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

equal to the following diagonal matrix

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

Here too,the price-cost margins of retailers and manufacturers can be computed under this assumption.

The model can also be considered where retailers and/or manufacturers collude perfectly simply by modifying ownership matrices. In the case of perfect price collusion between retailers, the price cost margins of the retail industry can be obtained by replacing the ownership matrices I_r in (2) by the identity matrix (the situation being equivalent to a retailer in a monopoly situation). Similarly, the price-cost margins vector for manufacturers can be obtained 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 label goods.

3.2 Two-Part Tariffs

The case is now considered where manufacturers and retailers sign two-part tariff contracts. Rey and Vergé (2004) prove the existence of and characterize equilibria in the following multiple common agency game in a two manufacturer - two retailer version. It is assumed that manufacturers simultaneously propose take-it or leave-it offers of two-part tariff contracts to each retailer. These contracts are public information and involve specifying franchise fees and wholesale prices but also retail prices in the case where manufacturers can use resale price maintenance. If one offer is rejected, then all contracts are refused[6]. If all offers are accepted, the retailers simultaneously set their retail prices and contracts are implemented. The fact that manufacturers make offers and that once an offer is rejected no contract is signed puts retailers at their participation constraint. Allowing retailers to make offers first would shift rents from the retailer to the manufacturer but the

[6] The characterization of equilibria in the opposite case is more difficult (Rey and Vergé, 2004). However, this assumption means that all manufacturers trading with all retailers should be observed, which is the case for bottled water in France.

set of price equilibria defined would be defined by the same sets of first order conditions. The outside option of the retailers is assumed to be given exogenously (minimum profit that the retailer can obtain if all contracts on this market are rejected). It will appear that the true profits of manufacturers and retailers are not identified since these constants can shift rents between parties without changing equilibria. Assuming that if one contract is refused not contract is signed implies that the party who receives the offer will obtain its reservation profit. Endogenizing the outside option is left for future research and is outside the scope of the present paper. It will appear that the set of possible equilibria obtained with this framework is already quite rich for the inference implemented in the empirical application.

Assuming that the offers of manufacturers are public is a convenient modelling hypothesis that can however be justified in France by the non-discrimination laws. In the two manufacturer - two retailer case, Rey and Vergé (2004) show that there exists 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]. Rey and Vergé (2004) show that it is always a dominant strategy for manufacturers to set retail prices in their contracting relationship with retailers, which is intuitive since by choosing retail prices and wholesale prices the manufacturer can at least replicate the equilibrium obtained by letting retailers fix their prices given wholesale prices and sometimes do better. The case is also considered where resale price maintenance would not be used by manufacturers because in some contexts, as in France, resale price maintenance may be forbidden.

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

$$\Pi^r = \sum_{j \in S_r} [M(p_j - w_j - c_j)s_j(p) - F_j] \tag{7}$$

where F_j is the franchise fee paid by the retailer for selling product j.

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

[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. Moreover, the monopoly profit function of the industry has to be single peaked as well as manufacturers revenue functions of the wholesale price vector.

maximize profits equal to

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

for firm f, subject to retailers' participation constraints $\Pi^r \geq \overline{\Pi}^r$, for all $r = 1, .., R$, where $\overline{\Pi}^r$ is the outside option of retailer r, supposed exogenous.

As shown in Rey and Vergé (2004), participation constraints are binding since otherwise manufacturers could reduce the fixed fees F_k given those of other manufacturers. The expressions for the franchise fee F_k of the binding participation constraint can be substituted into the manufacturer's profit (8) to obtain the following profit for firm f (see details in appendix 7.1 where reservation utilities $\overline{\Pi}^r$ are simply a constant to be added and that can be normalized to zero):

$$\Pi^f = \sum_{k \in G_f} (p_k - \mu_k - c_k)s_k(p) + \sum_{k \notin G_f} (p_k - w_k - c_k)s_k(p) \tag{9}$$

This shows that each manufacturer fully internalizes the entire margins on his products but internalizes only the retail margins on rivals' products. Furthermore, maximization of this objective function depends on whether resale price maintenance is used or not by manufacturers.

Remark that even if we assume publicly observable contracts and if retail price maintenance is illegal in France, it is nevertheless interesting to consider such an equilibrium since antitrust authorities may fail to enforce these regulatory constraints, or because it could be obtained by other means through more complicated nonlinear contracts (with more than two parts) without explicit RPM.

Two part tariffs with resale price maintenance:

Since manufacturers can capture retail profits through franchise fees and also set retail prices, wholesale prices have no direct effect on profit. Manufacturers have more control variables than needed and Rey and Vergé (2004) showed that this generates multiple equilibria (a continuum), with one for each wholesale prices vector that influence the strategic behavior of competitors. In fact, as can be seen in (9), manufacturer f profit does not depend on his own wholesale prices since fixed fees allow the manufacturer to capture the total margins on his own products. However, the wholesale prices set by other manufacturers do affect his profit through the retail margins on other products that fixed fees allow to be collected. Symmetrically, manufacturer f wholesale prices do not affect firm f profit but have a strategic role in influencing other manufacturers' profits as they internalize only retail margins on the products they do not own. Thus, 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.

To identify the two-part tariff models, the following possible equilibria are chosen. First, we consider the case where wholesale prices are equal to the marginal cost of production ($w_k^* = \mu_k$). In this case, retailers act as residual claimants and manufacturers capture the full monopoly rents through fixed fees. Second, we consider the case where wholesale prices are such that the retailer's price cost margins are zero ($p_k^*(w_k^*) - w_k^* - c_k = 0$). This case is considered by Berto Villas-Boas (2007) and implies that retail prices are chosen to maximize profits corresponding to the downstream vertically integrated structure for each of the J products. The retailers add only retail costs to the wholesale prices. In equilibrium, pricing decisions are thus implemented by the manufacturers and the share of total profits between retailers and manufacturers is then unidentified and will depend on the reservation profits $\overline{\Pi}^r$ of each party.

For a given equilibrium $p^*(w^*)$, the program of manufacturer f is now

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

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

$$\sum_{k\in G_f} (p_k - \mu_k - c_k)\frac{\partial s_k(p)}{\partial p_j} + s_j(p) + \sum_{k\notin G_f} (p_k^* - w_k^* - c_k)\frac{\partial s_k(p)}{\partial p_j} = 0 \quad \text{for all } j \in G_f \tag{10}$$

Then, depending on the wholesale prices, several equilibria can be considered.

First, when $w_k^* = \mu_k$, the first order conditions (10) can be expressed

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

i.e.

$$\sum_{k=1}^{J}(p_k - \mu_k - c_k)\frac{\partial s_k(p)}{\partial p_j} + s_j(p) = 0 \quad \text{for all } j \in G_f$$

which gives in matrix notation:

$$I_f S_p(\gamma + \Gamma) + I_f s(p) = 0. \tag{11}$$

In the case of private label 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

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

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

$$(\widetilde{I}_r S_p I_r)(\gamma + \Gamma) + \widetilde{I}_r s(p) = 0 \tag{12}$$

where $\widetilde{I}_r$ is the $(J \times J)$ ownership matrix of private label products of retailer r.

We thus obtain a system of equations with (11) and (12) 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:

$$\gamma + \Gamma = -\left(\sum\nolimits_r I_r S_p' \widetilde{I}_r S_p I_r + \sum\nolimits_f S_p' I_f S_p\right)^{-1}\left(\sum\nolimits_r I_r S_p' \widetilde{I}_r + \sum\nolimits_f S_p' I_f\right) s(p). \tag{13}$$

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

$$\gamma + \Gamma = -S_p^{-1} s(p) \tag{14}$$

because then $\sum_f I_f = I$.

This shows that two part tariff 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 (10) becomes

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

because products in $\{J', .., J\}$ are private labels which are also implicitly included in (10). In matrix notations, we get for all $f = 1, .., F$

$$\gamma_f + \Gamma_f = (p - \mu - c) = -(I_f S_p I_f)^{-1} \left[I_f s(p) + I_f S_p \widetilde{I}(\widetilde{\gamma} + \widetilde{\Gamma}) \right]$$

where $\widetilde{\gamma} + \widetilde{\Gamma}$ is the vector of all private label margins and $\widetilde{I}$ is the ownership matrix for private labels ($\widetilde{I} = \sum_r \widetilde{I}_r$).

In this case, profit maximizing strategic pricing of private labels by retailers is also taken into account by manufacturers when they choose fixed fees and retail prices for their own products in the contract. This implies that the prices of private labels chosen by retailers are 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

$$\widetilde{\gamma}_r + \widetilde{\Gamma}_r \equiv p - \mu - c = -\left(\widetilde{I}_r S_p \widetilde{I}_r \right)^{-1} \widetilde{I}_r s(p). \tag{15}$$

Two part tariffs without resale price maintenance:

Consider now the case where resale price maintenance cannot be used by manufacturers. Since they cannot choose retail prices, they just set wholesale prices in the following maximization program

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

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

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

which in matrix notation gives

$$I_f P_w s(p) + I_f P_w S_p I_f \Gamma + I_f P_w S_p (p - w - c) = 0.$$

This implies that the manufacturer price cost margin is:

$$\Gamma = (I_f P_w S_p I_f)^{-1} \left[-I_f P_w s(p) - I_f P_w S_p (p - w - c) \right] \tag{16}$$

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

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

4 Differentiated Product Demand

4.1 The Random Coefficients Logit Model

All the price-cost margins computations performed with the various assumptions as to behaviors of manufacturers and retailers require consistent estimates of demand parameters. The market demand is derived using a standard discrete choice model of consumer behavior that follows the work of Berry (1994), Berry, Levinsohn, and Pakes (1995), and Nevo (2001) among others. We use a random-coefficient logit model to estimate the demand system, as it is a highly flexible and general model (McFadden and Train, 2001). Contrary to the standard logit model, the random-coefficient logit model imposes very few restrictions on own and cross-price elasticities. This flexibility makes it the most appropriate model to obtain consistent estimates of the demand parameters required for computation of price-cost margins.

The basic specification of the indirect utility function giving rise to demand is given by

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

where V_{ijt} denotes the indirect latent utility of consumer i from buying product j during month t, β_j represents product fixed effects capturing time invariant product characteristics, γ_t are time dummies capturing monthly unobserved determinants of demand (like the weather), p_{jt} is the price of product j during month t, ξ_{jt} identifies the mean across consumers of unobserved (by the econometrician) changes in product characteristics, and ε_{ijt} represents separable additive random shocks. The random coefficient α_i represents the unknown marginal disutility of price for consumer i. This coefficient is allowed to vary across consumers according to

$$\alpha_i = \alpha + \sigma v_i$$

where v_i summarizes all the unobserved consumer characteristics, and σ is a coefficient that characterizes how consumer marginal disutilities of price vary with respect to average disutility α according to these unobserved characteristics. Indirect utility can be redefined in terms of the mean utility $\delta_{jt} = \beta_j + \gamma_t - \alpha p_{jt} + \xi_{jt}$ and deviations from the mean utility $\mu_{ijt} = -\sigma v_i p_{jt}$, i.e.

$$V_{ijt} = \delta_{jt} + \mu_{ijt} + \varepsilon_{ijt}.$$

The model is completed by the inclusion of an outside good, denoted good zero, allowing for the possibility of consumer i not buying one of the J_t marketed products. The price of this good is assumed to be set independently of the prices observed in the sample. The mean utility of the outside good is normalized to be zero and constant over time. The indirect utility of choosing the outside good is $U_{i0t} = \varepsilon_{i0t}$.

Idiosyncratic tastes ε_{ijt} are assumed to be independently and identically distributed according to Gumbel (extreme value type I) distribution. v_i is assumed to be normally distributed. Under these assumptions, the market share of product j for month t is given by

$$s_{jt} = \int_{A_{jt}} \left(\frac{\exp(\delta_{jt} + \mu_{ijt})}{1 + \sum_{k=1}^{J_t} \exp(\delta_{kt} + \mu_{ikt})} \right) \phi(v_i)\, dv_i \qquad (17)$$

where A_{jt} denotes the set of consumers traits that induce the purchase of product j during month t. Moreover, if $s_{ijt} \equiv \exp(\delta_{jt} + \mu_{ijt})/(1 + \sum_{k=1}^{J_t} \exp(\delta_{kt} + \mu_{ikt}))$, then the own and cross-price elasticities of the market share s_{jt} defined by equation (17) are

$$\eta_{jkt} \equiv \frac{\partial s_{jt}}{\partial p_{kt}} \frac{p_{kt}}{s_{jt}} = \begin{cases} -\frac{p_{jt}}{s_{jt}} \int \alpha_i s_{ijt}(1 - s_{ijt})\, \phi(v_i) dv_i & \text{if } j = k \\ \frac{p_{kt}}{s_{jt}} \int \alpha_i s_{ijt} s_{ikt}\, \phi(v_i) dv_i & \text{otherwise.} \end{cases} \qquad (18)$$

The random-coefficients logit model generates a flexible pattern of substitutions between products driven by the different consumer price disutilities α_i. Indeed, each consumer will have a different price disutility, which will be averaged to a mean price sensitivity using the consumer specific probabilities of purchase s_{ijt} as weights. Therefore, cross-price elasticities will not be constrained by the assumptions of homogeneity of marginal price disutility across consumers and by the functional form of probabilities as in the standard logit model.

4.2 Identification and Estimation of the Econometric Model

The GMM estimation procedure used follows the algorithm proposed by Berry, Levinsohn and Pakes (1995) and generalized to observed consumer heterogeneity by Nevo (2000 and 2001). The (nonlinear) GMM estimator was formed using the product of instrumental variables and an error term. More precisely, let Z be a set of instruments such that $E[Z'.u(\theta^*)] = 0$, where u, a function of the model parameters, is the error term ξ involved in the expression of the mean utility level and θ^* denotes the true value of the model parameters, the GMM estimate is then

$$\widehat{\theta} = \arg\min u(\theta)' Z \widehat{W} Z' u(\theta)$$

where $\widehat{W}$ is a consistent estimate of $[E[Z'uu'Z]]^{-1}$. The unobserved characteristics ξ appear in the expression of the mean utility levels δ_{jt}. These characteristics, expressed as a function of the data and the parameters of the model, are recovered by solving with respect to the mean utility levels the system of equations given by equating the observed market shares, denoted by S_{jt}, with the predicted market shares s_{jt}:

$$S_{jt} = s_{jt}(p, \xi; \theta). \tag{19}$$

For the multinomial logit model (i.e. without consumer heterogeneity) δ_{jt} is equal to $\ln(S_{jt}) - \ln(S_{0t})$, and $\xi_{jt} = \ln(S_{jt}) - \ln(S_{0t}) - (\beta_j + \gamma_t - \alpha p_{jt})$. For the random coefficients logit model (i.e. with consumer heterogeneity) the inversion used to recover has to be performed using the contraction mapping of Berry, Levinsohn and Pakes (1995). Therefore,

1. in a first step, the predicted market shares in equation (17) are approximated by

$$s_{jt} = \frac{1}{R} \sum_{r=1}^{R} \frac{\exp(\delta_{jt} + \mu_{rjt})}{1 + \sum_{k=1}^{J} \exp(\delta_{kt} + \mu_{rkt})}$$

   where R are the random draws from the distribution of the unobserved characteristic ν included in μ_{rjt}.

2. In a second step, for given values of the parameter σ, the nonlinear system of equations (19) is solved with respect to δ_{jt}s.

3. In a third step, the error term ξ is computed to interact with instruments and obtain the value of the GMM objective function.

4. In a final step, values of the parameter σ that minimize the objective function from step three are sought.[8]

We use the price of inputs of the bottling process as instruments. In fact, input prices should not be correlated with consumer demand shocks. As emphasized by Hellerstein (2004), input prices such as wages are unlikely to have any relationship to the types of promotional activity that will stimulate perceived changes in the characteristics of the products considered. The instruments used are the wage salary index for France and the diesel fuel and packaging material price indices. Indeed, labor, diesel fuel and packaging materials are three significant production factors in the processing and packaging of bottled water. These monthly figures come the French National Institute for Statistics and Economic Studies. These indices are interacted with dummy variables on the characteristics of each product as with the minerality of water. The underlying intuition is to allow each input to enter the production function of each product differently and in particular we suppose that the quality of the plastic involved in the processing and packaging of bottled water differs between mineral water or spring water. The estimation method also applies under the assumption that there is no serial correlation of unobservables.

[8] Nevo (2001) Matlab code was used to perform these estimations.

4.3 Testing Between Alternative Models

We now present how to test between alternative models once we have estimated the demand model and obtained the different price-cost margin estimates in accordance with the expressions obtained in the previous section. The estimation procedure consisting in estimating the demand model separately from the supply model is an efficient procedure since it dispenses with the need to reestimate the demand model for each supply model considered.

Considering model h, we denote γ_{jt}^h the retailer price cost margin for product j at time t and Γ_{jt}^h the manufacturer price cost margin under this model. Using $C_{jt}^h = \mu_{jt}^h + c_{jt}^h$ for the sum of the marginal cost of production and distribution, we know that

$$C_{jt}^h = p_{jt} - \Gamma_{jt}^h - \gamma_{jt}^h. \tag{20}$$

Assume now the following specification for these marginal costs

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

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

$$\ln C_{jt}^h = \omega_j^h + W_{jt}'\lambda_h + \ln \eta_{jt}^h. \tag{21}$$

Assuming that $E(\ln \eta_{jt}^h|\omega_j^h, W_{jt}) = 0$, ω_j^h, λ_h, and η_{jt}^h can be consistently identified and estimated.

The idea in testing the different models is thus to infer which cost equation has the best statistical fit given the observed cost shifters W_{jt} that depend on characteristics of the brand of product j and not on the conjectured model. This equation is subject to implicit restrictions, since for example products of the same brand but sold by different retailers will have the same brand characteristics appearing in W_{jt} but different costs C_{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, we implement the following:

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

Non-nested tests (Vuong, 1989, and Rivers and Vuong, 2002) are then applied to infer which model h is statistically the best. This involves testing models against each other. The test of Vuong (1989) applies in the context of maximum likelihood estimation and thus would apply in our case if log-normality of η_{jt}^h is assumed. Rivers and Vuong (2002) generalized this kind of test to a broad class of estimation methods including nonlinear 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 models accurately describes the data. This assumption cannot be sustained when dealing with a real data set in the present case.

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 distribution. The selection procedure involves comparing the sample value of T_n with critical values of the standard normal distribution[9]. In the empirical section, evidence based on these different statistical tests will be presented.

5 Econometric Estimation and Test Results

5.1 Data and Variables

Our data were collected by the company TNS-WorldPanel that conducts surveys about households' consumption in France. We have access to a representative survey of nearly 11,000 French households for the years 1998, 1999 and 2000, containing information on their purchases of all food products. The survey provides a description of the main characteristics of the goods and records the quantity, the price, the date and the store for all purchases over the whole period, and in particular on all bottled water purchased by these French households during the three years of study. We consider purchases in the seven most important retailers that represent 70.7% of the total purchases in the sample. The most important brands are taken into account, 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 label spring water. Purchases of these eight brands represent

[9] 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 $T_n < t_{\alpha/2}$ H_0 is rejected in favor of H_1; if $T_n > t_{\alpha/2}$ H_0 is rejected in favor of H_2. Otherwise, H_0 is not rejected.

71.3% of the purchases for the seven retailers. As will be shown in the demand estimation, robustness analysis is conducted in order to assess whether this selection of the most important brands introduces significant bias in the inference or not. The national brands are produced by three different manufacturers: *Danone*, *Nestlé* and *Castel*. This survey has the advantage of allowing market shares that are representative of the national French market to be computed thanks to a weighting procedure of the available household panel. Market shares are then defined by a weighted sum of the purchases of each brand during each month 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. Drinking water is assumed to be consumed by all households of the panel as the total size of the market. Thus, the outside good concerns tap water used only for drinking purposes as well as still water sold by retail stores not considered in the analysis and still water from small manufacturers sold in the seven retail stores studied. Considering that an individual has a mean drinking water consumption of 1.76 liters per day or 53 liters per month (Gofti-Laroche et al., 2001), the total size of the market can be computed by multiplying the monthly mean consumption by the total number of individuals in our panel each year.

Eight brands sold in seven distributors were considered, which gives more than 50 differentiated products on this national market. A product is defined by its brand and the retailer chain where it is sold. The number of products in our study thus varies between 51 and 54 over the 3 years considered. Considering the monthly (periods of 4 weeks are used) market shares of all of these differentiated products, we get a total of 2041 observations in our sample. Remark that when computing the aggregate market share, multiple choices and multiple purchases of households within each four-week period are implicitly included, which is equivalent to considering these multiple choices as coming from different purchase occasions in the random utility demand model considered. Then, for each of these products, an average price can also be computed for each month (in euros per liter). These data present both advantage and drawbacks. The advantage is that reliable nationally representative data can be used rather than data from just a few stores. The sample being quite large, it allows to compute monthly market shares and monthly prices without too much missing information. In fact, as all brands are purchased by some household at every retailer chain every month, the prices of all products are consistently observed and it can be considered that all prices are observed in the choice set of consumers for each period if prices were constant within that period. However, prices may vary within the four-week period implying a possible aggregation bias. Some robustness analysis with respect to this potential variability of prices within periods is thus necessary. The observed variance of prices within each month will be used to assess the robustness of estimation on our demand model. Moreover, using the French market provides a reliable analysis if pricing is done at the retail chain level rather than at the store level. In fact, average prices for each product are computed as the average brand price in a given retailer chain of all purchases during a 4-week period, that is, across purchases at different stores of the same retailer chain. As, there is little variation across stores of the same retailer chain compared with variations across retailer chains and across brands, we do not consider a more restricted market definition that would on the contrary increases the likelihood of not observing a lot of purchases for each product in a small size market.

Table 1 presents some first descriptive statistics on the main variables used.

Variable	Mean	Median	Std. dev.	Min.	Max	Nb. Obs.
Per Product Market share (all inside goods)	0.005	0.003	0.006	4.10^{-6}	0.048	2041
Per Product Market share: Mineral Water	0.004	0.003	0.003	10^{-6}	0.048	1496
Per Product Market share: Spring Water	0.010	0.007	0.010	10^{-5}	0.024	545
Price in €/liter	0.298	0.323	0.099	0.096	0.823	2041
Price in €/liter: Mineral Water	0.346	0.343	0.060	0.128	0.823	1496
Price in €/liter: Spring Water	0.169	0.157	0.059	0.096	0.276	545
Mineral water dummy (0/1)	0.73	1	0.44	0	1	2041
Market Share of the Outside Good	0.71	0.71	0.04	0.59	0.78	39

Table 1: Summary Statistics

Data from the French National Institute of Statistics and Economic Studies (INSEE) was also used on the plastic price, on a wage salary index for France, on oil and diesel fuel prices and on an index for packaging material cost. Over the time period considered (1998-2000), the wage salary index always rose while the plastic price index first declined during 1998 and the beginning of 1999 before rising again and reaching the 1998 level at the end of 2000. Concerning the diesel fuel price index, this shows quite significant 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 substantial variations with sharp growth in 1998, a decline at the beginning of 1999 and again an appreciable 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. In fact, it is likely that labor cost is not the same for the production of mineral and spring water but it is also known in this industry that the quality of plastic used for mineral or spring water is usually not the same and this is also likely to affect their bottling and packaging costs. Also, the relatively significant 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 estimated the demand model presented in section 4, as well as a standard multinomial logit model. The estimates of the random-coefficients logit model and the simple multinomial logit are in Table 2. The simple multinomial logit model is estimated using Two-Stage least squares with the same kind of instrumental variables.

Coefficients (Std. error)	Multinomial Logit	Random Coefficients Logit	
	(1)	(2)	(3)
Price (α)	5.47 (0.44)	8.95 (1.14)	10.74 (1.45)
Price (σ)		2.04 (0.81)	3.61 (1.20)
Std dev. of Price			0.81 (1.13)
Average distance			0.03 (0.06)
Coefficients δ_j, γ_t not shown			
Overidentifying restrictions test	6.30 ($\chi^2(10)$)	7.81 ($\chi^2(3)$)	12.50 ($\chi^2(8)$)

Table 2: Estimation Results of Demand Models

The results show that the price coefficient has the correct sign. In the case of the random coefficient logit model, the price coefficient has a distribution with mean equal to

8.95 and standard deviation equal to 2.04. This implies that an infinitesimal part of the distribution of the coefficient α_i is negative. In both estimations, all the 54 δ_j and 39 γ_t coefficients are not shown to save space. As Table 2 shows, the overidentifying restrictions tests are accepted.

As we said in section 5.1, the aggregate data come from the aggregation of a household survey and thus aggregation problems may raise some questions about the demand results. To ensure the reliability of our demand model, we conducted several specification tests before reaching the specification shown in Table 2. We also tried to investigate the question of possibly downward biased average prices by testing the robustness of our demand model with the following method. First, we computed the observed variance of each product price across purchases for any given month and introduced this product characteristic into the demand model. If our average prices are downward biased, this bias is likely to be positively correlated with the within month and across store variance of the price for a product. Then, introducing this characteristic in the demand model, we should expect a positive coefficient. This is what is found but the coefficient is small (0.809) and far from significant (its standard error being 1.14). Moreover, when this variable is introduced, it does not significantly change the estimates of our price coefficients α and σ. The same approach was applied by using the distance from home to the retailer (obtained with the observation of the location of the all supermarkets in France using LSA data, and using zip codes for households and geographical data on distances) as a characteristic of the product. The average distance of purchasers of each product at each month was calculated and introduced as a characteristic. Again, the other parameters of the demand model did not change significantly and the coefficient of this variable did not appear significant (its estimate was 0.031 with a standard error of 0.059). This was true whether introducing these variables jointly or not. Column (3) of Table 2 shows the results when both variables are introduced. Finally, we assessed the robustness of the simplification amounting to consider the most important brands (in terms of market share) by adding the next most important one. Adding one brand, whose market share is on average 0.022%

only, the results of the random coefficient logit model did not change significantly. The price coefficient was 9.8 and the coefficient of heterogeneity of tastes was 2.7. Moreover, with all these alternative specifications, the empirical results of interest that appear in the following did not change significantly.

Given the demand estimates, it is interesting to note that we find estimates of unobserved product specific mean utilities δ_j are found. Using these parameter estimates, their correlation with observed product characteristics can be considered using regression estimates. This is shown in Table 3 below.

GLS regression (with robust standard errors)		
Dependent Variable : Fixed Effects δ_j		
Explanatory variables	Coefficient (Std. error)	Coefficient (Std. error)
Mineral Water (0/1)	-2.76 (0.11)	4.71 (0.18)
Minerality	0.70 (0.05)	0.19 (0.08)
Manufacturer 1	6.14 (0.10)	
Manufacturer 2	5.53 (0.10)	
Manufacturer 3	-4.44 (0.09)	
Brand 3		-0.85 (0.18)
Brand 4		-1.57 (0.20)
Brand 5		-0.87 (0.17)
Brand 6		-3.00 (0.18)
Brand 7		-7.26 (0.17)
Retailer 2		0.26 (0.18)
Retailer 3		-0.71 (0.17)
Retailer 4		0.20 (0.18)
Retailer 5		0.25 (0.18)
Retailer 6		-0.35 (0.18)
Retailer 7		-0.13 (0.18)
Constant	2.96 (0.06)	2.59 (0.18)
F test (p value)	3576.20 (0.00)	308.12 (0.00)

Table 3: Regression of fixed effects on the product characteristics

The second column of 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 check for the manufacturer's identity this mean utility is larger for mineral water rather than spring water but is no longer the case when the manufacturer dummy variables are introduced. Finally, once the structural demand estimates have been obtained, price elasticities of demand for each differentiated product can be calculated. Table 4 shows the average elasticities for different groups of products.

Elasticities (η_{jk})	**Random Coefficients Logit**
All bottle water	Mean (Std. Deviation)
Own-price elasticity	-10.12 (2.65)
Cross-price elasticity	0.05 (0.02)
Mineral water	
Own-price elasticity	-11.38 (1.59)
Cross-price elasticity	0.06 (0.01)
Spring water	
Own-price elasticity	-6.64 (1.71)
Cross-price elasticity	0.03 (0.01)

Table 4: Summary of Elasticities Estimates

On average, own price elasticity is -10.1 and appears to be somewhat larger for mineral water rather than spring water, but the differences across all products also depend on the brands and retailer identity. Cross-price elasticities are positive but much less so in absolute value, which is not surprising given the number of products obtained by allowing products to differ not only by brand but also by retailer.

5.3 Price-Cost Margins

Once the demand parameters have been estimated, the formulas obtained in section 3 can be used to compute the price cost margins at the retailer and manufacturer levels or total price cost margins for all products, under the various scenarios considered. 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 tariff contracts (with RPM or not). Remark that the possibility of a Nash assumption in the vertical interaction in addition to a Stackelberg assumption as in Sudhir (2001) is considered. As explained at the end of 3.1, the Nash vertical interaction means that manufacturers and retailers behave simultaneously. This is equivalent to saying that manufacturers and retailers choose their margins. The models described in the following Table are considered (RPM means resale price maintenance and the producer is always a Stackelberg leader under nonlinear contracts).

Models	Retailer Behavior	Manufacturer 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 ($w = \mu$)
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, it is assumed that the retailer is also the producer, which amounts in our models to assuming that the behavior for pricing private labels is equivalent to that of a manufacturer perfectly colluding with the retailer for that good. Of course, only the total price cost margin is then computed for these private label goods because it then becomes meaningless to compute wholesale price and retail price margins separately.

Table 5 then shows the averages[10] of product level price cost margin estimates under the different models with the random-coefficients logit demand. It is worth noting that price cost margins are generally lower for mineral water than for spring water. As in Nevo (2001), price cost margins can then be compared 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 retailer and manufacturer margins prevents such analysis. Moreover, accounting data only provide an upper bound for price-cost margins.

[10] Note that the average price-cost margin at retailer level plus the average price-cost margin at manufacturer level do not sum to the total price cost margin because of the private labels products for which no price cost margin at manufacturer level is computed, with the retailer price cost margin then being 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	13.48	1.43	19.80	3.60
	Manufacturers	9.90	0.77	20.62	1.13
	Total	**23.07**	**1.67**	**43.91**	**2.16**
Model 2	Retailers	13.48	1.44	19.80	3.60
	Manufacturers	9.77	0.64	19.02	1.09
	Total	**22.94**	**1.50**	**42.31**	**2.11**
Model 3	Retailers	13.48	1.43	19.80	3.60
	Manufacturers	11.99	0.88	22.32	1.04
	Total	**25.10**	**1.84**	**45.61**	**2.11**
Model 4	Retailers	13.48	1.43	19.80	3.60
	Manufacturers	12.76	0.75	21.35	0.97
	Total	**25.94**	**1.69**	**44.63**	**2.03**
Model 5	Retailers	9.45	1.48	16.49	4.06
	Manufacturers	9.90	0.77	20.62	1.13
	Total	**19.02**	**1.65**	**41.05**	**2.19**
Model 6	Retailers	9.45	1.48	16.49	4.06
	Manufacturers	10.53	4.12	20.20	1.95
	Total	**19.66**	**4.22**	**40.64**	**2.56**
Model 7	Retailers	9.45	1.48	16.49	4.06
	Manufacturers	11.93	0.88	22.32	1.04
	Total	**21.05**	**1.73**	**42.75**	**2.09**
Model 8	Retailers	9.45	1.48	16.49	4.06
	Manufacturers	13.42	2.96	22.75	3.79
	Total	**22.54**	**3.04**	**43.19**	**3.96**
Two part Tariffs with RPM					
Model 9	Nash and $w = \mu$	**12.90**	**1.03**	**17.87**	**5.29**
Model 10	Nash and $p = w + c$	**10.85**	**1.06**	**16.70**	**4.61**
Model 11	Collusion and $p = w + c$	**12.93**	**1.03**	**17.95**	**5.20**
Two-part Tariffs without RPM					
Model 12	Retailers	9.45	1.48	16.49	4.06
	Manufacturers	2.94	1.13	1.93	0.43
	Total	**12.07**	**1.36**	**22.45**	**1.04**

Table 5: Estimated Price-Cost Margins

As expected, it can be seen that total price-cost margins are much lower for two-part tariff models than for linear pricing models. Although the most significant source of variation in margins lies in the comparison of linear versus nonlinear pricing models, margins still vary quite substantially among linear pricing models only or among two-part tariff models. Under linear pricing, when there is no collusion at the retailer level, retailers' margins are on average smaller than manufacturers' margins but still quite high for the food retailing sector.

5.4 Estimates of cost equations and nonnested tests

After estimating the different price cost margins for the models considered, the marginal cost C_{jt}^h can be derived using equation (20) and then estimate cost equations. Table 6 shows the empirical results of estimation of the cost equation (21) for $h = 1, ..., 12$ 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 fuel, packaging material and plastic price variables interacted with the dummy variable for spring water (SW) and mineral water (MW).

$\ln C_{jt}^h$ Coeff. (Std. err.)	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
salary × SW	0.03 (0.21)	0.04 (0.20)	-0.02 (0.21)	-0.02 (0.21)	0.12 (0.21)	-0.01 (0.22)
salary× MW	0.16 (0.18)	0.16 (0.18)	0.10 (0.18)	0.09 (0.18)	0.25 (0.18)	0.08 (0.23)
plastic× SW	-0.02 (0.09)	-0.02 (0.09)	-0.02 (0.09)	-0.03 (0.09)	-0.02 (0.09)	-0.07 (0.11)
plastic× MW	-0.02(0.08)	-0.01 (0.08)	-0.02 (0.08)	-0.02 (0.08)	-0.02 (0.08)	-0.10 (0.10)
packaging× SW	0.11 (0.05)	0.11 (0.05)	0.12 (0.05)	0.12 (0.05)	0.08 (0.05)	0.13 (0.07)
packaging× MW	0.10 (0.05)	0.10 (0.05)	0.11 (0.05)	0.11 (0.05)	0.07 (0.05)	0.10 (0.06)
diesel× SW	0.05 (0.02)	0.03 (0.03)	0.03 (0.03)	0.03 (0.03)	0.03 (0.03)	0.04 (0.03)
diesel× MW	0.03 (0.03)	0.05 (0.02)	0.05 (0.02)	0.05 (0.02)	0.06 (0.02)	0.09 (0.02)
oil× SW	-0.02 (0.03)	-0.02 (0.03)	-0.02 (0.03)	-0.02 (0.04)	-0.01 (0.03)	-0.04 (0.04)
oil× MW	-0.05 (0.02)	-0.05 (0.02)	-0.05 (0.02)	-0.05 (0.02)	-0.05 (0.02)	-0.11 (0.03)
constant	-2.05 (2.00)	-2.06 (1.97)	-1.59 (2.01)	-1.42 (1.99)	-2.62 (1.98)	-0.78 (2.45)
All δ_t=0 F test (p val.)	2.89 (0.00)	2.86 (0.00)	3.00 (0.00)	2.96 (0.00)	2.75 (0.001)	3.59 (0.00)
All ω_j^h=0 F test (p val.)	490.1 (0.00)	480.4 (0.00)	499.5 (0.00)	493.9(0.00)	493.8 (0.00)	320.4 (0.00)

Table 6 : Cost Equations for the Random Coefficients Logit Model

$\ln C_{jt}^h$ Coeff. (Std. err.)	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
salary× SW	0.07 (0.21)	0.04 (0.21)	0.06 (0.19)	0.12 (0.19)	0.08 (0.17)	0.11 (0.19)
salary× MW	0.20 (0.18)	0.06 (0.18)	0.18 (0.17)	0.24 (0.17)	0.20 (0.17)	0.20 (0.17)
plastic× SW	-0.02 (0.09)	-0.05 (0.09)	-0.01 (0.08)	-0.02 (0.09)	-0.02 (0.09)	-0.04 (0.08)
plastic× MW	-0.02 (0.08)	-0.05 (0.08)	-0.01 (0.08)	-0.02 (0.08)	-0.02 (0.08)	-0.07 (0.08)
packaging× SW	0.09 (0.05)	0.10 (0.05)	0.10 (0.05)	0.08 (0.05)	0.09 (0.05)	0.10 (0.05)
packaging× MW	0.08 (0.05)	0.09 (0.05)	0.09 (0.04)	0.06 (0.04)	0.07 (0.04)	0.09 (0.04)
diesel× SW	0.03 (0.03)	0.03 (0.03)	0.03 (0.03)	0.03 (0.02)	0.03 (0.03)	0.03 (0.03)
diesel× MW	0.05 (0.02)	0.06 (0.02)	0.05 (0.02)	0.05 (0.02)	0.05 (0.02)	0.07 (0.02)
oil× SW	-0.02 (0.03)	-0.03 (0.03)	-0.01 (0.03)	-0.01 (0.03)	-0.01 (0.03)	-0.03 (0.03)
oil× MW	-0.04 (0.02)	-0.09 (0.05)	-0.05 (0.02)	-0.04 (0.02)	-0.04 (0.02)	-0.07 (0.03)
constant	-2.19 (1.99)	-0.94 (2.02)	-2.06 (1.85)	-2.39 (1.85)	-2.05 (1.84)	-1.74 (1.89)
All δ_t=0 F test (p val.)	2.68 (0.001)	2.68 (0.001)	2.96 (0.000)	2.80 (0.001)	2.76 (0.001)	3.54 (0.000)
All ω_j^h=0 F test (p val.)	504.1 (0.00)	489.2 (0.00)	395.6 (0.00)	390.5 (0.00)	392.9 (0.00)	299.7 (0.00)

Table 6 (continued): Cost Equations for the Random Coefficients Logit Model

The results of these cost equations are useful mostly in order to test which model best fits the data. However, it is interesting to see that even if product level dummies and period dummies are highly significant, other explanatory variables are also worthy of note. In particular, the packaging cost variable is almost always significant, while oil and diesel price indices are also quite often significant. Salary indices and plastic cost variables are never significant at the 5% conventional level. Finally, the significance of these variable cost shifters vary across equations, that is across models. The coefficients of the cost shifters are always of the same sign across models but the absolute values of these coefficients can vary from one to four across models.

The Rivers and Vuong non-nested tests explained in section 4.3 were then performed. The results are given in Table 7. In order to take into account the fact that each cost equation uses cost estimates that have been estimated after the estimation of the demand model, the bootstrap was used. The statistics of test[11] shown in Table 7 are thus bootstrap statistics with 100 replications. The results finally show that the best model appears to be the model 10, that is the case where manufacturers use two part tariff contracts with resale price maintenance. The Vuong (1989) tests based on the maximum likelihood estimation of the cost equations under normality provides the same inference concerning the best model (see Table 9 in appendix 7.4).

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

Rivers and Vuong Test Statistic $T_n = \frac{\sqrt{n}}{\hat{\sigma}_n}\left(Q_n^2(\hat{\Theta}_n^2) - Q_n^1(\hat{\Theta}_n^1)\right) \rightarrow N(0,1)$

H_1 \ H_2	2	3	4	5	6	7	8	9	**10**	11	12
1	-8.26	6.38	-1.53	-5.30	2.16	-3.52	2.33	-7.81	**-7.54**	-7.42	-1.31
	(5.64)	(3.88)	(6.70)	(2.52)	(3.51)	(2.52)	(3.42)	(3.16)	**(3.00)**	(2.81)	5.02)
2		8.38	6.38	2.19	2.74	7.14	3.24	-6.69	**-6.97**	-6.26	-0.81
		(5.55)	(4.41)	(7.35)	(4.09)	(6.98)	(5.24)	(4.24)	**(4.56)**	(4.33)	(6.26)
3			-5.37	-5.95	2.06	-5.62	2.11	-7.95	**-7.55**	-7.47	-1.26
			(8.17)	(3.38)	(3.82)	(3.21)	(3.66)	(4.10)	**(3.67)**	(3.46)	(5.11)
4				-1.99	1.79	0.10	2.51	-7.58	**-7.97**	-7.20	-1.58
				(7.46)	(4.06)	(7.40)	(4.99)	(4.29)	**(5.45)**	(4.49)	(6.05)
5					3.11	5.59	3.43	-7.81	**-7.72**	-7.47	-0.83
					(3.45)	(3.07)	(4.86)	(3.53)	**(3.74)**	(3.32)	(5.51)
6						-2.56	0.45	-5.17	**-5.62**	-5.26	-3.95
						(3.45)	(4.77)	(2.89)	**(3.68)**	(3.04)	(4.72)
7							2.93	-8.03	**-7.92**	-7.74	-1.07
							(4.21)	(3.76)	**(3.24)**	(3.51)	(5.32)
8								-5.84	**-6.19**	-5.84	-3.92
								(4.39)	**(5.39)**	(4.34)	(3.85)
9									**-4.47**	-2.14	2.88
									(3.85)	(3.83)	(3.46)
10										**4.32**	**4.13**
										(4.63)	**(4.29)**
11											2.97
											(3.94)

Table 7: Results of the Rivers and Vuong Test for the Random Coefficients Logit Model

The non-rejected model indicates 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 in principle this is not legal in France. In this equilibrium, variable retail margins are zero but total profits including fixed fees are unidentified. It is interesting, however, to note that this equilibrium is such that manufacturers are residual claimants. Zero retail margins also imply that fixed fees paid by retailers to manufacturers are negative if the outside option (reservation profit) of retailers is strictly positive. Thus this model implies that manufacturers pay some sort of slotting allowances to retailers, a practice for which the press often reports evidence in France. Although resale price maintenance is illegal in France, our empirical result shows that contractual relationships imply pricing strategies that allow this equilibrium to be replicated. It is worth noting that this pricing equilibrium could be reached through the use of two part tariff contracts with resale price maintenance, but it is possible that it is actually implemented through more complex non-linear contracts that would not involve resale price maintenance.

For this model, the estimated total price cost margins (price minus marginal cost of production and distribution), are relatively low with an average of 11% for mineral water and 17% for spring water. These figures are lower than the rough accounting estimates that can be obtained from aggregate data (see section 2). As Nevo (2001) remarks, the accounting margins only provide an upper bound for 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 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. Absolute margins are on average 0.037 € for mineral water and 0.025€ for spring water. With the best model, average price-cost margins for national brand products versus private labels products can be evaluated. 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 10.68% for national brands and 12.61% 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 21.20% instead of 12.22%.

5.5 Simulating Counterfactual Policy Experiments

Estimation of the structural demand and cost parameters now allows some counterfactual policy experiments to be simulated. First the method used to simulate these counterfactual policy experiments will be presented, followed by the particular policies and simulation results considered.

The previous estimation and inference allow a vector of marginal costs of production and distribution for the preferred model to be estimated. We denote by I_f, I_r, the true ownership matrices for manufacturers and retailers and h the preferred pricing equilibrium according to the data. We denote $C_t = (C_{1t}, .., C_{jt}, .., C_{Jt})$ the vector of the marginal costs for all products present at time t, where $C_{jt} = p_{jt} - \Gamma_{jt} - \gamma_{jt}$. Then, given these marginal costs and the other estimated structural parameters, some policy experiments can be simulated using equilibrium conditions of the supply model considered and using I_f^* and I_r^* the respective ownership matrices of manufacturers and retailers under the counterfactual policy.

Consider the policy experiment where product's ownership has been changed to I_f^*, I_r^*. Equilibrium prices p_t^* as solutions of the first order equations obtained under the chosen policy experiment have to be solved. For example in the case of two part tariffs with RPM:

$$p_t^* + (I_f^* S_p(p_t^*))^{-1} I_f^* s(p_t^*) = C_t. \tag{22}$$

Market shares $s(p_t^*)$ and their derivatives $S_p(p_t^*)$ depend of equilibrium prices p_t^* and the demand model. According to (17), each market share depends on the vector of prices as

$$s_{jt}(p_t^*) = \int_{A_{jt}} \left(\frac{\exp(\delta_{jt}^* + \mu_{ijt}^*)}{1 + \sum_{k=1}^{J_t} \exp(\delta_{kt}^* + \mu_{ikt}^*)} \right) \phi(v_i) dv_i$$

which is estimated as $\frac{1}{R}\sum_{r=1}^{R} \frac{\exp(\delta_{jt}^* + \mu_{rjt}^*)}{1+\sum_{k=1}^{J_t} \exp(\delta_{kt}^* + \mu_{rkt}^*)}$ where R is the number of draws used to compute the market share by simulation. Moreover, using (18), each element of the matrix of derivatives of the demand $S_p(p_t^*)$ can be computed as

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

Thus solving the nonlinear equation (22) whose unknowns are the prices p_{jt}^*, simulated equilibrium prices under such policy are obtained. Market shares are obtained using simulated prices. The solution vector p_t^* of

$$\min_{\{p_{jt}^*\}_{j=1,..,J}} \left\| p_t^* + (I_f^* S_p(p_t^*))^{-1} I_f^* s(p_t^*) - C_t \right\| \tag{23}$$

is sought where $\|.\|$ is a norm of $\mathbb{R}^J$. In practice, the Euclidean norm in $\mathbb{R}^J$ will be taken.

Given equilibrium prices under the counterfactual policy, the change in consumer surplus of any counterfactual policy by $CS_t(p_t) - CS_t(p_t^*)$ can be evaluated using the usual formula for the random coefficients logit model

$$CS_t(p_t) = \frac{1}{|\alpha_i|} E\left[\max_j V_{ijt}(p_t)\right] = \frac{1}{|\alpha_i|} \ln\left(\sum_{j=1}^{J} \exp\left[V_{ijt}(p_t)\right]\right).$$

Remark that the profits of firms are not identified since the equilibrium conditions allow a solution for the prices but not for the fixed fees.

Table 8 shows the results of simulations of different policies. Average effects are presented given that one simulation per period is performed and the standard deviations of all these simulations are shown in parentheses. As the parameters of demand and cost used to perform the simulations are estimated, standard errors of all simulated policies on prices, market shares and consumer surplus can be obtained by bootstrap. However, solving the system of equations (23) is already quite long and doing this for each bootstrap replication of the whole estimation and simulation for all periods is extremely time-consuming. The results of the simulation must thus be taken with caution since standard errors are not computed. However, the bootstrap of test statistics and cost equations in the previous section show that the precision of results was fairly robust.

In Table 8, the first simulation considers the case of a de-merger of Nestlé and Perrier. The merger of these companies that occurred in 1992 has been controversial. This merger transferred Contrex from Perrier to Nestlé while Volvic (of Perrier) went over to Danone (BSN). The results of the simulation show that prices would decrease with such a de-merger which would suggest that the merger has increased prices. The consumer surplus variation also shows that the merger would have led to a decrease by a little more than 1%. Table 10 also shows the results of the linear pricing case (without changing ownership of products), a supply model where the effect of the double marginalization on retail prices can be clearly seen.

In 1996, the "Galland" Act was introduced. This law requires retailers not to resell under the wholesale price, giving manufacturers the power to impose resale price maintenance by choosing their wholesale price. The Galland Act was removed in 2006 under the assumption that it helped some food industries maintain high prices. One way to see this reform is to consider the case where no resale price maintenance would be used by manufacturers. Simulating the two part tariffs without RPM, we can see that the consumer surplus would increase by 0.8%. On average, prices would decrease for most national brands except for private labels. This simulation shows that removing the Galland Act in 2006 should have had beneficial effects on prices for consumers. Using data before and after the implementation of this law, Biscourp, Boutin and Vergé (2008) show with reduced form regressions that this law actually had an inflationary effect on prices in 1996. A result which is in line with our policy experiment that can be seen as the dismantling of the Galland Act.

Policy	% Change of price p^*_{jt}	% Change in market share s^*_{jt}
Nestlé/Perrier de-merger		
Average	-1.65 (0.13)	14.60 (1.61)
Average for Danone (BSN)	-1.59 (0.09)	14.52 (1.51)
Average for Nestlé	-1.93 (0.16)	19.09 (2.71)
Average for Perrier	-1.80 (0.18)	15.98 (2.30)
Average for Castel	-0.56 (0.19)	1.46 (1.02)
Average for Private Labels	-0.48 (0.21)	0.89 (1.88)
Average for outside good		-0.21 (0.02)
$\frac{CS_t(p_t)-CS_t(p^*_t)}{CS_t(p_t)}$ in %	1.35 (0.24)	
Double Marginalization (linear pricing)		
Average	6.73 (9.19)	-40.05 (56.79)
Average for Danone	6.82 (6.42)	-52.37 (6.33)
Average for Nestlé	7.23 (7.42)	-54.17 (9.24)
Average for Castel	15.45 (13.51)	-43.09 (141.71)
Average for Private Labels	–0.47 (6.41)	10.82 (2.81)
Average for outside good		1.05 (0.09)
$\frac{CS_t(p^*_t)-CS_t(p_t)}{CS_t(p_t)}$ in %	-13.18 (23.24)	
Two part Tariffs without RPM		
Average	-7.44 (5.44)	71.11 (50.12)
Average for Danone	-7.30 (0.66)	78.45 (9.33)
Average for Nestlé	-7.45 (0.85)	82.92 (12.15)
Average for Castel	-19.05 (1.52)	148.75 (21.81)
Average for Private Labels	0.30 (0.16)	-17.99 (2.80)
Average for outside good		-2.07 (0.42)
$\frac{CS_t(p_t)-CS_t(p^*_t)}{CS_t(p_t)}$ in %	0.81 (0.39)	

Table 8: Policy experiments results

6 Conclusion

In this paper, the first empirical estimation of a structural model taking into account explicitly two part tariff contracts in a vertical relationship as between manufacturers and retailers in the supermarket industry was presented. Several alternative models of competition between manufacturers and retailers on a differentiated product market and test between these alternatives were considered. In particular, attention was devoted to two types of nonlinear pricing relationships with two part tariff contracts, with or without resale price maintenance. The method is based on estimates of demand parameters that allow price-cost margins at the manufacturer and retailer levels to be recovered. Testing was then conducted between the different models using exogenous variables that are supposed to shift the marginal cost of production and distribution. This methodology was applied to study the market for retailing bottled water in France. Our empirical analysis allows it to be concluded that manufacturers and retailers use nonlinear pricing contracts and in particular two part tariff contracts with resale price maintenance. Finally, it was possible to simulate some counterfactual policy experiments related to the nonlinear pricing mechanisms used by manufacturers and retailers. This paper's contribution is to allow for estimation of a structural model with a rich set of equilibria under nonlinear contracts. The methodology developed allows different vertical contracting models to be tested in a context of oligopoly both at upstream and downstream levels. For this purpose, as in Rey and Vergé (2004) a game is adopted where upstream firms play first and can make take-it-or-leave-it offers to downstream firms. We leave for further research the analysis of more complex interactions where offers and counter offers could be made in a more dynamic setting. In Gans (2007), orders precede procurement. Downstream firms play first and he shows that even with nonlinear tariffs an oligopolistically competitive outcome is obtained. However, the model of Gans is restricted to an upstream monopolist facing competing downstream firms, which is not true of the framework studied here. In any case, it is true that the models considered are static and that relationship between manufacturers and retailers are in fact repeated. We leave for further research the analysis of dynamic models that will probably be much more complex. Adding the possibility of storage at several stages of the model will also be needed in the future.

Further developments estimating supply models of oligopolistic competition under nonlinear pricing are needed. In particular, further studies are required where assumptions of non-constant marginal cost of production and distribution would be allowed. 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. Another research direction that seems promising would involve in developing the present framework to use necessary inequality conditions instead of first order conditions for the identification of bounds on the different margins at the retail and wholesale levels. Rosen's approach (2006) where the strategic interaction is imperfectly known or Pakes et al. (2006) can thus be applied for future research on the framework proposed with two part tariff contracts. 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

The theoretical results due to Rey and Vergé (2004) are 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

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

so that

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

Then, the firm f profits are

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

Since producers set fixed fees given those of other producers, the following obtains under resale price maintenance:

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

and with no resale price maintenance

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

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

7.2 Detailed resolution of system of equations

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

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

where A_f and B_f are given matrices.

Solving this system amounts to solve the minimization problem

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

which 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 the following expression to be found as solution

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

7.3 Identification method for 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 the observed cost shifter W_{jt}, unobserved product specific effects ω_j, and unobserved shocks η_{jt}, we have

$$C_{jt} = \exp(\omega_j + W_{jt}'\lambda)\eta_{jt}.$$

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

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

and 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 price cost margin equations, a price equation can also be obtained

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

Identifying the parameters of this price equation would then require specification of the joint law of unobservable shocks (η_{jt}, u_t). Thus, our two-step method has the advantage of providing identification of demand and cost parameters under weaker assumptions. In particular no assumptions need to be made on the correlation between unobserved shocks (η_{jt}, u_t).

7.4 Additional non-nested tests

Vuong (1989) Test Statistic											
\\	H_2										
H_1	2	3	4	5	6	7	8	9	**10**	11	12
1	-21.13	8.28	-2.62	-7.53	4.36	-4.77	3.97	-14.88	**-14.57**	-14.15	-0.98
	(13.58)	(6.96)	(10.18)	(4.56)	(6.87)	(4.09)	(5.62)	(7.01)	**(6.05)**	(5.93)	(8.21)
2		16.73	8.17	1.58	5.57	7.90	5.33	-11.66	**-12.67**	-11.54	0.19
		(10.29)	(5.78)	(9.43)	(8.87)	(9.63)	(10.44)	(7.11)	**(6.41)**	(6.00)	(12.20)
3			-13.77	-8.20	4.64	-8.11	4.18	-16.68	**-14.74**	-14.90	-0.60
			(16.94)	(7.28)	(8.27)	(7.00)	(8.00)	(10.18)	**(7.94)**	(8.15)	(10.06)
4				-3.21	4.37	-0.64	4.86	-14.21	**-14.12**	-13.59	-0.55
				(9.68)	(8.57)	(10.02)	(11.74)	(7.79)	**(7.39)**	(6.92)	(12.90)
5					5.76	7.22	5.61	-1182	**-14.89**	-12.77	-0.44
					(6.42)	(4.72)	(8.18)	(5.27)	**(6.83)**	(5.72)	(8.55)
6						-5.13	0.11	-9.12	**-10.31**	-9.73	-5.97
						(6.72	(5.59)	(6.40)	**(8.15)**	(7.24)	(6.39)
7							5.01	-14.09	**-16.21**	-14.94	-0.68
							(7.48)	(7.01)	**(7.58)**	(7.00)	(3.69)
8								-9.56	**-10.24**	-9.54	-4.61
								(10.56)	**(13.36)**	(10.63)	(5.05)
9									**-5.04**	-2.25	4.75
									(6.89)	(4.33)	(5.83)
10										**5.52**	**7.38**
										(6.72)	**(11.04)**
11											6.11
											(7.54)

Table 9: Results of the Vuong Test for the Random Coefficients Logit Model