WORKING PAPERS

N° TSE-575

May 2015

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May 2015‡

Résumé

Using typical demand data on differentiated products markets, we show how to identify and estimate vertical contract terms modelling explicitly the buyer power of downstream firms facing two part tariff offered by the upstream firms. We consider manufacturers and retailers relationships with two part tariff with or without resale price maintenance and allow retailers to have a buyer power determined by the horizontal competition of manufacturers. Our contribution allows to recover price-cost margins at the upstream and downstream levels as well as fixed fees of two-part tariff contracts using the industry structure and estimates of demand parameters. Empirical evidence on the market for bottles of water in France shows that two part tariff contracts are used without resale price maintenance and that the buyer power of supermarket chains is endogenous to the structure of manufacturers competition. We are able to estimate total fixed fees and profits across manufacturers and retailers.

Key words : vertical contracts, two part tariff, buyer power, retailers, differentiated products.

JEL codes : L13, L81, C12, C33

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‡We are grateful to Patrick Rey and participants of many seminars and conferences for helpful comments. A previous incomplete version circulated under the title "Non Linear Contracting and Endogenous Buyer Power between Manufacturers and Retailers : Empirical Evidence on Food Retailing in France" and benefited from comments by J.F. Houde, B. Jullien, T. Magnac, A. Nevo, V. Nocke, A. Pakes, A. Petrin, K. Sudhir, T. Vergé, S. B. Villas-Boas, Q. Vuong, M. Whinston.

1 Introduction

Many industries present horizontal and vertical oligopoly structures where upstream sellers deal with downstream buyers. This is particularly the case in markets where manufacturers sell their products through retailing chains, for example for most processed food items in supermarkets. These vertical relationships matter considerably for the final price setting by retailers, for competition and market power analysis. The nature of contracts and the sharing of rents in the vertical chain are then important determinants of equilibrium outcomes.

This paper proposes the first identification and estimation of a vertical contracting structural model taking explicitly into account the buyer power of downstream players facing non linear contracts such as two part tariff contracts offered by the upstream level. We consider contracts between manufacturers and retailers whose buyer power comes from the horizontal competition of manufacturers. We also consider the case where manufacturers could use another contingency in contracting such as resale price maintenance. Using industry structure and estimates of demand parameters, our contribution shows how to recover price-cost margins at the upstream and downstream levels as well as fixed fees of two part tariff contracts in these different structural models. This allows to recover completely the profits of all firms in the industry.

Recent works in empirical industrial organization have started taking into account the strategic behavior of retailers in the vertical chain as intermediaries between upstream producers and consumers. As information on wholesale prices, on marginal costs of production or distribution, and on vertical restraints are generally difficult to observe, methods often rely on demand side data and require a structural modelling of the supply side. Usual empirical industrial organization methods propose to address the estimation of price-cost margins using structural models of competition on differentiated products markets such as cars, computers, breakfast cereals, beer (Berry, 1994, Berry, Levinsohn and Pakes, 1995, Nevo, 1998, 2000, 2001, Pinkse and Slade, 2004, Slade, 2004, Ivaldi and Martimort, 1994, Ivaldi and Verboven, 2005, Dubois and Jodar-Rosell, 2010). Recent research studies identification with relaxed assumption on strategic behavior (Rosen, 2007) or using only some best response behavior (Pakes, Porter, Ho and Ishii, 2015). For long, most papers in this literature assumed that retailers act as neutral pass-through intermediaries or charge exogenous constant margins as if manufacturers directly set consumer prices. Chevalier, Kashyap and Rossi (2003) showed the important role of distributors on prices and the strategic role of retailers has been recently emphasized in the economics and marketing empirical literatures. While each paper having its own focus, a stream of research introduces an explicit consideration of the strategic role of retailers (for example, Goldberg and Verboven (2001), Manuszak (2010), Mortimer (2008), Ho (2006), Ho, Ho and Mortimer (2012), Sudhir (2001), Villas-Boas and Zhao (2004), Asker (2005), Villas-Boas (2007), Hellerstein (2008), Meza and Sudhir (2010)). In particular, Sudhir (2001) considers the strategic interactions between manufacturers and a single retailer on a local market and focuses on a linear pricing model leading to double marginalization. Meza and Sudhir (2010) study how private labels affect the bargaining power of retailers. Ho (2006) studies the welfare effects of vertical contracting between hospitals and health maintenance organizations in the US. Ho (2009) looks at the role of managed care health insurers on the choice of hospitals using the inequality framework of Pakes, Porter, Ho and Ishii (2015). Asker (2005) considers the role of foreclosure in the strategic choices of vertical contracts on the beer market. Hellerstein (2008) explains imperfect pass-through again in the beer market. Manuszak (2010) studies the impact of upstream mergers on retail gasoline markets using a structural model allowing downstream prices to be related to upstream price mark-ups and wholesale prices chosen by upstream gasoline refineries. Hellerstein and Villas-Boas (2010) study the role of foreign outsourcing on the pass-through rate of upstream part suppliers in the automobile industry. Villas-Boas (2009) studies the effects of a ban on wholesale price discrimination on the German coffee market. Bonnet, Dubois, Villas-Boas and Klapper (2013) study the effects of vertical restraints, and in particular of non linear contracts with resale price maintenance, on the cost pass through of the world market price of coffee on retail prices in Germany. Moreover, the introduction of retailers' strategic behavior has considered mostly cases where competition between producers and/or retailers remains under linear pricing (like in Sudhir, 2001, Brenkers and Verboven, 2006). One exception is Villas-Boas (2007) who considers the possibility that vertical contracts between manufacturers and retailers make pricing strategies depart from double marginalization by setting alternatively wholesale margins or retail margins to zero. Bonnet and Dubois (2010) extended the analysis modelling explicitly two-part tariff contracts with or without resale price maintenance, but assuming that the buyer power of retailers is exogenously fixed. The consideration of endogenous buyer power within a vertical relationship coming from horizontal competition at the upstream level has never been taken into account and changes both qualitatively and quantitatively the nature of equilibria.

Then, more recent work on identification and estimation of bargaining in vertical chains have been developed with Grennan (2013, 2014), Gowrisankaran, Nevo, Town (2015). Grennan (2013) makes advantage of the observation of individual transaction prices between stent manufacturers and hospitals to estimate a structural bargaining model. In their model, manufacturers and hospitals (playing here the role of intermediary between stent producers and patients/doctors) bargain over the price using bilateral Nash Bargaining à la Horn and Wolinsky (1988) as in Crawford and Yurukoglu (2012).

Here, we consider a different contracting framework where upstream firms do not bargain but make take-it or leave-it offers to downstream firms who however benefit from some buyer power by the ability to refuse offers while accepting others. As in bilateral Nash bargaining, equilibrium prices will not be uniform and non linear contracts (two part tariffs) will allow prices to depart from standard Bertrand Nash equilibrium. Empirical estimation of bargaining models (Grennan, 2013, Gowrisankaran, Nevo, Town (2015)) rely on exogenously given bargaining parameters. Here, we model the upstream party as having a Stackelberg leader role with take-it or leave-it offers but allow retailers to benefit from their buyer power when facing manufacturers contracts offers. The buyer power is endogenously determined by the available competing offers of other manufacturers that can be used as outside options by retailers in addition to the profits obtained from their private label own brands (store brands).

We show how we can identify and estimate price-cost margins at the retailer and manufacturer levels under the different competition scenarios considered without observing marginal costs and wholesale prices. Modelling explicitly optimal two-part tariff contracts (with or without resale price maintenance) allows to recover the pricing strategy of manufacturers and retailers. We do not only recover the total price-cost margins as functions of demand parameters but also the contractual fixed fees and the division of these margins between manufacturers and retailers. Using additional restrictions on the cost structure allows us to test between the different models.

We apply our modelling to the bottled water market in France using estimates of a mixed logit demand model on individual level data. In previous work, Bonnet and Dubois (2010) use the same market in the late 90s to show how to identify and infer what types of vertical contracts were used in the retailer chain. This market presents a high degree of concentration both at the manufacturer and retailer levels. It is to be noted that it is actually even more concentrated at the manufacturer level with only three large manufacturers than at the retailer level where we have in France seven large retailing chains. Considering only two part tariffs contracts with exogenously given outside options, Bonnet and Dubois (2010) cannot identify all contractual terms of non linear tariffs but showed that resale price maintenance was at work in a period where the regulatory rules defining resale at loss were not including fixed rebates, thus facilitating the use of high wholesale prices in order to impose high retail prices to supermarkets. Here, we present results of identification of more general two part tariffs contracts, and show how to obtain unobserved fixed fees of two part tariffs. In the empirical application, we use more recent data that happen after an important change in the regulation of manufacturers-retailers contracts, allowing downstream retailers to potentially exploit their buyer power. Empirical evidence shows that two-part tariff contracts are used without resale price maintenance and that the buyer power of supermarket chains is endogenously determined by the offers of the multiple manufacturers. Our empirical results can be related to changes in regulatory rules regarding resale below cost in France that previously led to resale price maintenance equilibria. We finally obtain empirical estimates of fixed fees in addition to retail and wholesale margins which allows us to decompose profits sharing in the industry at the upstream and downstream levels. We find that some retailers need pay fixed fees that represent roughly between 10 and 25% of their variable profits whereas one retailer chain obtains substantial backward margins (negative fees).

In section 2, we first present some stylized facts on the bottled water market in France, an industry where the questions of vertical relationships and competition of manufacturers and retailers seem worth studying. Section 3 describes the main methodological contribution. We show how price-cost margins and contracts can be identified once we know the demand shape, using the observed industry structure and structural assumptions on vertical contracts. In section 4, we present the demand model, its identification and estimation on individual data as well as empirical results and tests. Section 5 concludes.

2 The Bottled Water Market in France

2.1 Stylized Facts

The bottled water market is an important sector of the French food processing industry : 68.2 billion liters were sold in 2006 (Agreste, 2009). This market has not grown in France since then while it is growing much faster in many other countries including the US and emerging markets such as Mexico, China. It is also a highly concentrated sector since the three main producers (Nestlé Waters, Danone, and Castel) share 90% of the total production of the sector in France. Two types of unflavored water coexist, namely, natural mineral water and spring water. The denomination of "natural mineral" water is officially recognized by an agreement from the French Ministry of Health and puts forward properties favorable to health. Composition must be guaranteed as well as the consistency of a set of qualitative criteria : mineral content, visual aspects, and taste. The exploitation of a "spring water" source requires a license provided by local authorities and an agreement of the local health committee but the water composition is not required to be constant. The differences between the quality requirements involved in the certification of these two kinds of water may explain part of the large differences that exists between the shelf prices of the mineral and spring water brands.

In France, households buy bottled water mostly in supermarkets (80% of total sales) and on average, these sales represent 1.7% of the total turnover of supermarkets, the bottled water shelf being one of the most productive. Manufacturers thus deal mainly their brands through retailing chains which are also highly concentrated on food retailing (the market share of the first five being around 80% of total food retailing). Since the late 90s, food retailing chains have developed private labels (also called store brands) and the increase in the number of private labels tends to be accompanied by a reduction of the market shares of the main national brands.

This market is very concentrated and competition concerns are usually put forward. Like in many countries, regulation of the food retailing industry exhibits strong rules on zoning and entry of supermarket stores (Bertrand and Kramarz, 2002, Jodar-Rosell, 2008) and also restrictions about vertical contracting between manufacturers and retailers, notably with rules on resale below cost (Allain and Chambolle, 2011). Consistent with the below cost pricing regulation in France in 1996, Bonnet and Dubois (2010) showed that the observed pricing could be explained by contracts with resale price maintenance (RPM) during the period 1998-2000. This evidence is consistent with the fact that the Galland act (introduced in 1996) prohibited resale at loss by retailers defining the threshold level of prices from wholesale list prices without including any backward margins (Allain and Chambolle, 2011). Implementing implicitly RPM was then feasible with this regulation. Such concern led to the removal of the Galland act by the competition authority with a new law called "Dutreil II" elaborated in 2005 and effective on January 2006. There is thus a policy interest in studying competition and pricing relationships after 2006 as such legislation exists or existed not only in France (Galland Act from 1996 to 2005) but also in other countries like, e.g. Ireland (Groceries Orders), Spain (Law on Unfair Competition), where the conditional or deferred rebates that are not written on the invoice are or were excluded from the legal minimum price threshold.

2.2 Data and Variables

Our data were collected by home-scan technique by the Kantar company and consist of a survey on households' purchase. We use a representative sample of French households for the year 2006 for which we have information on their purchases of all food products. The data provide a description of the main characteristics of the goods whose purchases are recorded over the whole year at the bar code level. We thus have quantity, price, brand, date and store of purchase. We use the information on all bottles of still water purchased. For the purpose of estimation of our structural models, we will consider the purchases in the seven most important retailers which represent 70.9% of the total purchases of the sample. We take into account the most important brands, that is : five national brands of mineral water, one national brand of spring water, one retailer private label brand of mineral water and one retailer private label spring water. The purchases of these eight brands represent 69.3% of the purchases of the seven retailers. The national brands are produced by three different manufacturers : *Danone*, *Nestlé Waters* and *Castel*.

These eight brands sold in seven retailer chains give 56 differentiated products. For each of these products, we compute an average price for each month using all observed purchases by households during the month. Table 1 presents some first descriptive statistics on some of the main variables used.

Table 1 : Summary Statistics

Variable	Mean	Median	Std. dev.	Min.	Max
Price in €/liter	0.251	0.213	0.127	0.113	0.929
Price in €/liter : Mineral Water	0.369	0.359	0.034	0.200	0.929
Price in €/liter : Spring Water	0.148	0.134	0.034	0.113	0.313
Mineral water dummy (0/1)	0.66	1	0.47	0	1

3 Identifying Margins and Contract Relationships Between Manufacturers and Retailers

We now turn to the modelling of vertical contracts between manufacturers and retailers and study the conditions of identification of price cost margins and contracts. We introduce an oligopoly model with vertical relationships. We consider the benchmark cases of linear pricing and two part tariffs contracts with exogenously given outside options (as in Bonnet and Dubois (2010)), and then show new results on the modelling and identification of margins and contracts when retailers benefit from some endogenous buyer power when facing manufacturers' two part tariffs offers. In this section, we develop the identification results assuming that the demand function is known as well as retail prices for a set of T markets since we know that we can identify the demand independently of any assumption on the supply side as we will remind in section 4 .

Let's introduce the model considering R retailers and F multi-brand manufacturers. We denote J the number of differentiated products defined by the brand-retailer pair among which J' products are manufacturer branded products and $J-J'$ are store brands (also called private labels). We denote S_r the set of products sold by retailer r and G_f the set of products produced by firm f.

3.1 Benchmark case of Linear Pricing

Let's consider the case where manufacturers set wholesale prices first, and retailers follow by setting the retail prices. We obtain the usual double marginalization result. For private labels, prices are chosen by the retailer who bears both retailing and production costs. Using backward induction, the retailer's problem consists in maximizing its profit denoted Π^r for retailer r and equal to

$$\Pi^r = \sum\nolimits_{j\in S_r}(p_j - w_j - c_j)s_j(\mathbf{p})$$

where p_j is the retail price of product j, w_j is the wholesale price of product j, c_j is the retailer's (constant) marginal cost of distribution for product j, $s_j(\mathbf{p})$ is the market share of product j, $\mathbf{p}$ is the vector of retail prices of all products.

Remark that we normalized the profit by the market size but will re-scale them at the country level when needed. Since we will take into account an outside good option denoted good 0, this normalization is equivalent as if we had used the total demand of each good instead of market shares.

Assuming that a pure-strategy Bertrand-Nash equilibrium in prices exists, prices must satisfy the system of equations given by first-order conditions

$$s_j + \sum\nolimits_{k \in S_r} (p_k - w_k - c_k) \frac{\partial s_k}{\partial p_j} = 0, \tag{1}$$

for all $j \in S_r$ and all $r = 1, .., R$.

This system of equations allows to identify all retail margins as function of the demand and of observed equilibrium prices. As using vector notations will prove useful, we define I_r as the $(J \times J)$ diagonal matrix whose (j, j) element is 1 if $j \in S_r$ and zero otherwise. Let S_p be the matrix of partial derivatives of all market shares with respect to all retail prices, i.e.

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

Denoting the vector of retail margins $\boldsymbol{\gamma} \equiv \mathbf{p} - \mathbf{w} - \mathbf{c}$, the first order conditions (1) imply that for all r[1]

$$I_r \boldsymbol{\gamma} = -\left(I_r S_p(\mathbf{p}) I_r\right)^{-1} I_r s(\mathbf{p}) \tag{2}$$

where we obtain $\boldsymbol{\gamma}$ using $\boldsymbol{\gamma} = \sum_{r=1}^{R} I_r \boldsymbol{\gamma}$ because the left multiplication by I_r amounts to replace rows that does not correspond to products of retailer r by zeros. Remark that for private labels, this price-cost margin is in fact the total price-cost margin which amounts to replace the wholesale price $\mathbf{w}$ by the marginal cost of production $\boldsymbol{\mu}$ in this formula.

Concerning the manufacturers' behavior, we assume they maximize profit choosing the wholesale prices w_j of their own products and given the retailers' response (1). The profit of manufacturer f is given by

$$\Pi^f = \sum\nolimits_{j \in G_f} (w_j - \mu_j) s_j(\mathbf{p}(\mathbf{w}))$$

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,

[1] Abusing notations, we consider the generalized inverse when noting the inverse of non invertible matrices, which means that for example $\begin{bmatrix} 2 & 0 \\ 0 & 0 \end{bmatrix}^{-1} = \begin{bmatrix} 1/2 & 0 \\ 0 & 0 \end{bmatrix}$.

the first order conditions are

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

for all $j \in G_f$ and all $f = 1, .., F$.

This system of equations allows to identify all wholesale margins as function of the demand function, equilibrium prices and retail price reactions to wholesale prices that are also identified by totally differentiating (1).

It is again convenient to use matrix notation, with I_f the diagonal matrix and whose (j, j) element is one if $j \in G_f$ and zero otherwise and P_w the $J \times J$ matrix of partial derivatives of the J retail prices with respect to the J' wholesale prices. Remark that the last $J - J'$ rows of this matrix are zero because they correspond to private label products.

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

Denoting the vector of manufacturer's margins $\mathbf{\Gamma} \equiv \mathbf{w} - \boldsymbol{\mu}$, the first order conditions (3) imply that for all $f = 1, .., F$:

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

Assuming that retailers follow manufacturers in setting the retail prices given the wholesale prices, $P_w(\mathbf{w})$ 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 $k = 1, .., J'$ (omitting arguments) :

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

where $1_{\{k \in S_r\}} = 1$ if $k \in S_r$ and 0 otherwise. Defining $S_p^{p_j}$ the matrix of the second partial derivatives of market shares with respect to p_j and all prices :

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

we can solve the system of equations (5) to obtain $P_w = \sum_{r=1}^{R} I_r P_w$ with[2] :

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

where $\widetilde{I}_r$ is the diagonal matrix where element (j,j) is one if j is a private label of retailer r and zero otherwise ($I_r - \widetilde{I}_r$ is thus the ownership matrix of national brands by retailer r).

Thus, one can express the manufacturer's price-cost margins vector $\boldsymbol{\Gamma} = \mathbf{w} - \boldsymbol{\mu}$ as depending on the demand shape and equilibrium prices using (6) to solve for P_w in (4). As already known, with linear pricing between manufacturers and retailers, both manufacturer level and retailer level price-cost margins are identified with (2) and (4).

3.2 Two-Part Tariffs Contracts with Retail Buyer Power

We now consider the case where manufacturers and retailers can sign two-part tariff contracts. We assume that manufacturers make take-it-or-leave-it offers to retailers and characterize symmetric subgame perfect Nash equilibria. Rey and Vergé (2010) have proven the existence of equilibria of this multiple common agency game. Two part tariffs contracts consist in the specification of franchise fees and wholesale prices and can include retail prices in the case where manufacturers use resale price maintenance (RPM). All offers are public[3] and retailers simultaneously accept or reject. Contrary to Bonnet and Dubois (2010), where it is assumed that if one offer is rejected then all contracts are refused and retailers obtain a fixed reservation utility, we allow the possibility that a retailer rejects a contract while accepting others. Once offers have been accepted, the retailers simultaneously set their retail prices, demands and contracts are satisfied.

As two-part tariff contracts are negotiated at the firm level and not by brand, multi-brand manufacturers make bundling offers to retailers. Retailers can then refuse a manufacturer's offer and accept those of other manufacturers. Remark that these multi-brand bundling contracts imply that a retailer cannot refuse part of the brands offered by a manufacturer while accepting others

[2] We use the notation $(a|b)$ for horizontal concatenation of a and b. The full matrix P_w can be obtained by summing over r these expressions.

[3] This is a convenient benchmark case that can be justified in France by the nondiscrimination laws of the 1986 edict of free pricing which prevents the offer of different wholesale prices to purchasers who provide comparable services.

owned by this same manufacturer. The more products are owned by a manufacturer, the larger will be his market power and the lower the buyer power of retailers.

The profit function of retailer r now writes :

$$\Pi^r = \sum\nolimits_{j\in S_r}[(p_j - w_j - c_j)s_k(\mathbf{p}) - F_j] \tag{7}$$

where F_j is the franchise fee paid by the retailer r for selling product $j \in S_r$ (F_j can be negative if backward margins are received by the retailer). The profit function of firm f is equal to

$$\Pi^f = \sum\nolimits_{j\in G_f}[(w_j - \mu_j)s_j(\mathbf{p}) + F_j]. \tag{8}$$

Contract offers are simultaneous but the incentive constraints of the retailers are such that contracts offered by a manufacturer to a retailer must provide to the retailer a profit at least as large as the profit that the retailer would obtain when refusing the proposed contract but accepting all other offers. In addition to these incentive compatibility conditions, retailers' profits must be at least larger than some fixed reservation profit level denoted $\overline{\Pi}^r$ for retailer r (that could be normalized to zero or to some fixed exogenous opening operation cost).

Thus, manufacturers set the two-part tariff contracts (wholesale prices and fixed fees) in order to maximize profits as in (8) subject, for all $r = 1,..,R$, to the following retailers' participation constraints

$$\Pi^r \geq \overline{\Pi}^r, \tag{9}$$

and incentive constraints

$$\Pi^r \geq \sum\nolimits_{j\in S_r\backslash G_{fr}}[(\widetilde{p}_j^{fr} - w_j - c_j)s_j(\widetilde{\mathbf{p}}^{fr}) - F_j] \tag{10}$$

where Π^r is the retailer's profit (7) when accepting all offers, G_{fr} is the set of products owned by firm f and distributed by retailer r, and $\widetilde{\mathbf{p}}^{fr} = (\widetilde{p}_1^{fr},..,\widetilde{p}_J^{fr})$ is the vector of retail prices when the products in G_{fr} are not sold (by convention we will have $\widetilde{p}_i^{fr} = +\infty$ if $i \in G_{fr}$) because r refused the offer of f.

When the retailer r refuses the offer of the manufacturer f but accepts all other offers, retailer r sell all products not manufactured by f, whose set is denoted $S_r\backslash G_{fr}$. The market share $s_j(\widetilde{\mathbf{p}}^{fr})$

of each product of the set $S_r \backslash G_{fr}$ corresponds to the market share of product j when all products in G_{fr} are absent.

As constraint (10) imply an upper bound on total fixed fees obtained by each manufacturer from each retailer :

$$\sum_{j \in G_{fr}} F_s \leq \sum_{j \in S_r} \left[(p_j - w_j - c_j) s_j(\mathbf{p}) - (\widetilde{p}_j^{fr} - w_j - c_j) s_j(\widetilde{\mathbf{p}}^{fr}) \right], \tag{11}$$

following Rey and Vergé (2010) arguments, given a vector of wholesale prices, each manufacturer can always increase the fixed fees such that the constraint (11) will be binding provided the values of $\overline{\Pi}^r$ are not too large.

Actually, constraints (10) imply that

$$\begin{aligned}
\Pi^r &= \sum_{j \in S_r} [(p_j - w_j - c_j) s_k(\mathbf{p})] - \sum\nolimits_{f=1,..F} \sum\nolimits_{j \in G_{fr}} F_j \\
&\geq \sum_{j \in S_r} [(p_j - w_j - c_j) s_k(\mathbf{p})] - \sum_{f=1,..F} \sum_{j \in S_r} \left[(p_j - w_j - c_j) s_j(\mathbf{p}) - (\widetilde{p}_j^{fr} - w_j - c_j) s_j(\widetilde{\mathbf{p}}^{fr}) \right]
\end{aligned}$$

and the participation constraints (9) will be satisfied when $\overline{\Pi}^r$ is lower than the right hand side of the above equation. As this right hand side variable could be made very low and even negative by decreasing wholesale prices, participation constraints (9) may become binding while (10) remains a strict inequality.

In the following, we consider both cases where either (9) or (10) bind. If constraints (10) are binding, the sum of fixed fees paid for the products of f sold through r is

$$\sum_{j \in G_{fr}} F_s = \sum_{j \in S_r} \left[(p_j - w_j - c_j) s_j(\mathbf{p}) - (\widetilde{p}_j^{fr} - w_j - c_j) s_j(\widetilde{\mathbf{p}}^{fr}) \right] \tag{12}$$

because $s_j(\widetilde{\mathbf{p}}^{fr}) = 0$ when $j \in G_{fr}$. Remark that this is not necessarily positive as it will depend on the way retail prices are set in case of disagreement between f and r.

Using this expression, one can then rewrite the profit of the manufacturer f as

$$\begin{aligned}
\Pi^f &= \sum_{j \in G_f} [(w_j - \mu_j) s_j(\mathbf{p}) + F_j] = \sum_{j \in G_f} (w_j - \mu_j) s_j(\mathbf{p}) + \sum\nolimits_{r=1}^{R} \sum_{j \in G_{fr}} F_j \\
&= \sum_{j \in G_f} (w_j - \mu_j) s_j(\mathbf{p}) + \sum\nolimits_{r=1}^{R} \sum_{j \in S_r} \left[(p_j - w_j - c_j) s_j(\mathbf{p}) - (\widetilde{p}_j^{fr} - w_j - c_j) s_j(\widetilde{\mathbf{p}}^{fr}) \right]
\end{aligned}$$

because $\cup_{r=1}^{R} G_{fr} = G_f$ (and $G_{fr} \cap G_{fr'} = \varnothing$). The manufacturer's profit is then

$$\begin{aligned}
\Pi^f &= \sum_{j \in G_f} (w_j - \mu_j) s_j(\mathbf{p}) + \sum_{j=1}^{J} \left[(p_j - w_j - c_j) s_j(\mathbf{p}) - (\widetilde{p}_j^{fr(j)} - w_j - c_j) s_j(\widetilde{\mathbf{p}}^{fr(j)}) \right] \qquad (13) \\
&= \sum_{j \in G_f} (p_j - \mu_j - c_j) s_j(\mathbf{p}) + \sum_{j \notin G_f} \left[(p_j - w_j - c_j) s_j(\mathbf{p}) - (\widetilde{p}_j^{fr(j)} - w_j - c_j) s_j(\widetilde{\mathbf{p}}^{fr(j)}) \right]
\end{aligned}$$

where $r(j)$ denotes the retailer of product j.

We will also consider a simpler case where constraints (10) are never binding which amounts to not consider those incentive constraints as in Bonnet and Dubois (2010). Then, the outside opportunities depend on a fixed exogenous reservation profit and the buyer power of retailer is exogenously determined. This could happen if outside options of retailers are strong and independently determined (for example by the opportunity value of saved space in supermarkets). Then, as shown in Bonnet and Dubois (2010), the manufacturers profit becomes

$$\Pi^f = \sum_{j \in G_f} (p_j - \mu_j - c_j) s_j(\mathbf{p}) + \sum_{j \notin G_f} (p_j - w_j - c_j) s_j(\mathbf{p}) - \sum_{j \notin G_f} F_j - \sum_{r=1,.,R} \overline{\Pi}^r$$

and the maximization is equivalent to set wholesale prices in the following program

$$\max_{\{w_j\}_{j \in G_f}} \sum_{j \in G_f} (p_j - \mu_j - c_j) s_j(\mathbf{p}) + \sum_{j \notin G_f} (p_j - w_j - c_j) s_j(\mathbf{p}) \qquad (14)$$

instead of maximizing (13).

We now consider two possibilities regarding two part tariffs contracts. We first consider that manufacturers are not using resale price maintenance (RPM) in their contracts but set wholesale prices and retailers set retail prices. Then, as it may be a dominant strategy to use RPM, even if it's against the law, we also consider the case where RPM may be used.

3.2.1 *Without Resale Price Maintenance*

We first consider the case where manufacturers cannot use resale price maintenance (RPM) in their contracts. In this case, the mappings $\widetilde{\mathbf{p}}^{fr}(\mathbf{w})$ from wholesale prices to retail prices are out of equilibrium prices and correspond to the retail prices when r refuses the offer of f but accepts all others. Given the retail price equilibrium mappings $\mathbf{p}(\mathbf{w})$ and the out of equilibrium mappings

$\widetilde{\mathbf{p}}^{fr}(\mathbf{w})$ for all f and r, the first order conditions of the maximization of the profit of f (13) with respect to wholesale prices w_j, can be written for all $j \in G_f$:

$$\begin{aligned}
0 &= \sum_{i=1}^{J} \sum_{k \in G_f} (w_k - \mu_k) \frac{\partial s_k(\mathbf{p})}{\partial p_i} \frac{\partial p_i}{\partial w_j} + \sum_{k=1}^{J} \left[\frac{\partial p_k}{\partial w_j} s_k(\mathbf{p}) - \frac{\partial \widetilde{p}_k^{fr(k)}}{\partial w_j} s_k(\widetilde{\mathbf{p}}^{fr(k)}) \right] \\
&+ \sum_{i=1}^{J} \sum_{k=1}^{J} \left[(p_k - w_k - c_k) \frac{\partial s_k(\mathbf{p})}{\partial p_i} \frac{\partial p_i}{\partial w_j} - \left(\widetilde{p}_k^{fr(k)} - w_k - c_k \right) \frac{\partial s_k(\widetilde{\mathbf{p}}^{fr(k)})}{\partial p_i} \frac{\partial p_i}{\partial w_j} \right]
\end{aligned}$$

where $r(k)$ denotes the retailer index of product k.

In matrix notation, omitting unnecessary arguments, the previous first order conditions give

$$0 = I_f P_w S_p I_f \mathbf{\Gamma} + I_f P_w s(\mathbf{p}) - I_f \tilde{P}_w^f s(\widetilde{\mathbf{p}}^f) + I_f P_w S_p \gamma - I_f P_w S_{\widetilde{p}}^f \widetilde{\boldsymbol{\gamma}}^f$$

where the matrix $S_{\widetilde{p}}^f$ is

$$S_{\widetilde{p}}^f \equiv \begin{pmatrix} \frac{\partial s_1(\widetilde{\mathbf{p}}^{fr(1)})}{\partial p_1} & .. & \frac{\partial s_J(\widetilde{\mathbf{p}}^{fr(J)})}{\partial p_1} \\ \vdots & & \vdots \\ \frac{\partial s_1(\widetilde{\mathbf{p}}^{fr(1)})}{\partial p_J} & .. & \frac{\partial s_J(\widetilde{\mathbf{p}}^{fr(J)})}{\partial p_J} \end{pmatrix}$$

and $\tilde{P}_w^f$ is the matrix of partial derivatives of retail prices $\widetilde{p}_j^{fr(j)}(\mathbf{w})$ (for $j = 1, .., J$) with respect to wholesale prices $\mathbf{w}$.

Thus the wholesale margins of products of manufacturer f are

$$I_f \mathbf{\Gamma} = - \left[I_f P_w S_p I_f \right]^{-1} \left(I_f P_w s(\mathbf{p}) - I_f \tilde{P}_w^f s(\widetilde{\mathbf{p}}^f) + I_f P_w S_p \boldsymbol{\gamma} - I_f P_w S_{\widetilde{p}}^f \widetilde{\boldsymbol{\gamma}}^f \right) \tag{15}$$

where $\boldsymbol{\gamma}$ comes from (2) and $\widetilde{\boldsymbol{\gamma}}^f \equiv (\widetilde{\gamma}_1^f, .., \widetilde{\gamma}_J^f)$ where $\widetilde{\gamma}_j^f$ is the j^{th} row element of vector $-(I_{r(j)} S_{\widetilde{p}}^f I_{r(j)})^{-1} I_{r(j)} s(\widetilde{\mathbf{p}}^f)$.

Remark that out of equilibrium retail prices can be obtained from observed equilibrium retail prices, retail margins at equilibrium and out of equilibrium retail margins using : $\widetilde{p}_j^{fr(j)} = \widetilde{\gamma}_j^{fr(j)} - (p_j - w_j - c_j) + p_j$ where $\widetilde{\gamma}_j^{fr(j)} = \widetilde{p}_j^{fr(j)} - w_j - c_j$ is the out of equilibrium retail margin. Moreover, $\tilde{P}_w^f$ can be deduced from the differentiation of the retailer's first order conditions with respect to wholesale prices. These first order conditions are, for all $r = 1, .., R$ and all $j \in S_r$,

$$s_j(\widetilde{\mathbf{p}}^{fr}) + \sum_{k \in S_r \backslash G_{fr}} (\widetilde{p}_k^{fr} - w_k - c_k) \frac{\partial s_k(\widetilde{\mathbf{p}}^{fr})}{\partial \widetilde{p}_j^{fr}} = 0$$

which gives for $r=1,..,R$, $j\in S_r$ and $k=1,..,J'$

$$\begin{aligned} 0 \;=\;& \sum_{l\in\{1,..,J\}\backslash G_{fr}} \frac{\partial s_j(\widetilde{\mathbf{p}}^{fr(j)})}{\partial \widetilde{p}_l^{fr(j)}}\frac{\partial \widetilde{p}_l^{fr(j)}}{\partial w_k} - 1_{\{k\in S_r\}}\frac{\partial s_k(\widetilde{\mathbf{p}}^{fr(j)})}{\partial \widetilde{p}_j^{fr(j)}} + \sum_{l\in S_r}\frac{\partial s_l(\widetilde{\mathbf{p}}^{fr(j)})}{\partial \widetilde{p}_j^{fr(j)}}\frac{\partial \widetilde{p}_l^{fr(j)}}{\partial w_k} \\ &+ \sum_{l\in S_r\backslash G_{fr}}\left[(\widetilde{p}_l^{fr}-w_l-c_l)\sum_{m\in\{1,..,J\}\backslash G_{fr}}\frac{\partial^2 s_l(\widetilde{\mathbf{p}}^{fr(j)})}{\partial \widetilde{p}_j^{fr(j)}\partial \widetilde{p}_m^{fr(j)}}\frac{\partial \widetilde{p}_m^{fr(j)}}{\partial w_k}\right] \end{aligned} \tag{16}$$

Defining $S_{\tilde{p}^f}^{p_j}$ the $J\times J$ matrix of the second partial derivatives of the market shares whose element (s,l) is $\frac{\partial^2 s_l(\widetilde{\mathbf{p}}^{fr(j)})}{\partial \widetilde{p}_j^{fr(j)}\partial \widetilde{p}_k^{fr(j)}}$, i.e.

$$S_{\tilde{p}^f}^{p_j} \equiv \begin{pmatrix} \frac{\partial^2 s_1(\widetilde{\mathbf{p}}^{fr(j)})}{\partial \widetilde{p}_j^{fr(j)}\partial \widetilde{p}_1^{fr(j)}} & \cdots & \frac{\partial^2 s_J(\widetilde{\mathbf{p}}^{fr(j)})}{\partial \widetilde{p}_j^{fr(j)}\partial \widetilde{p}_1^{fr(j)}} \\ \vdots & . & \vdots \\ \frac{\partial^2 s_1(\widetilde{\mathbf{p}}^{fr(j)})}{\partial \widetilde{p}_j^{fr(j)}\partial \widetilde{p}_J^{fr(j)}} & \cdots & \frac{\partial^2 s_J(\widetilde{\mathbf{p}}^{fr(j)})}{\partial \widetilde{p}_j^{fr(j)}\partial \widetilde{p}_J^{fr(j)}} \end{pmatrix},$$

we can write equation (16) to obtain

$$\tilde{P}_w^f\left[S_{\tilde{p}}^f + I_r S_{\tilde{p}}^{f\prime} + (S_{\tilde{p}^f}^{p_1} I_r\widetilde{\boldsymbol{\gamma}}^{fr}|...|S_{\tilde{p}^f}^{p_J} I_r\widetilde{\boldsymbol{\gamma}}^{fr})\right] I_r - I_r S_{\tilde{p}}^f\left(I_r-\widetilde{I}_r\right)=0$$

where $\widetilde{\boldsymbol{\gamma}}^{fr}=\widetilde{\mathbf{p}}^{fr}-\mathbf{w}-\mathbf{c}$.

Defining $M_{fr}\equiv\left[S_{\tilde{p}}^f + I_r S_{\tilde{p}}^{f\prime} + (S_{\tilde{p}^f}^{p_1} I_r\widetilde{\boldsymbol{\gamma}}^{fr}|...|S_{\tilde{p}^f}^{p_J} I_r\widetilde{\boldsymbol{\gamma}}^{fr})\right]$ we can solve this system of equations and get the following expression for $\tilde{P}_w^f$

$$\tilde{P}_w^f = -\left(\sum\nolimits_{r=1}^R I_r M_{fr}' I_r S_{\tilde{p}}^f (I_r-\widetilde{I}_r)\right)\left(\sum\nolimits_{r=1}^R I_r M_{fr}' M_{fr} I_r\right)^{-1}$$

Equation (15) shows that one can express the manufacturer's price-cost margins as depending on the demand function and the structure of the industry by replacing the expression of $\tilde{P}_w^f$. We thus obtain that both the manufacturer level and retailer level margins are identified using (2) and (15) to obtain respectively $I_f\boldsymbol{\gamma}$ and $I_f\boldsymbol{\Gamma}$ for all $f=1,..,F$.

In the case where the retailers' buyer power is exogenously because constraints (10) are irrelevant and only constraints (9) have to be taken into account, the first order conditions are of maximization of (14) are : for all $i\in G_f$,

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

which gives in matrix notation

$$I_f P_w s(\mathbf{p}) + I_f P_w S_p I_f(\mathbf{p}-\boldsymbol{\mu}-\mathbf{c}) + I_f P_w S_p \left(I - I_f\right)(\mathbf{p}-\mathbf{w}-\mathbf{c}) = 0$$

This implies that the total price-cost margin is such that for all $f = 1, .., F$,

$$I_f\left(\boldsymbol{\gamma}+\boldsymbol{\Gamma}\right) = \left(I_f P_w S_p I_f\right)^{-1}\left[-I_f P_w s(\mathbf{p}) - I_f P_w S_p \left(I - I_f\right)(\mathbf{p}-\mathbf{w}-\mathbf{c})\right]. \tag{17}$$

Using (2) to replace $(\mathbf{p}-\mathbf{w}-\mathbf{c})$ and (6) for P_w, this allows us to identify all price-cost margins. Remark again that the formula (2) provides directly the total price-cost margin obtained by each retailer on its private label.

Then, in the case where the incentive constraints (12) are binding, we can identify total fixed fees $\sum_{j\in G_{fr}} F_j$ paid by any retailer r to any manufacturer f using

$$\sum_{j\in G_{fr}} F_s = \sum_{j\in S_r}\left[(p_j - w_j - c_j)s_j(\mathbf{p}) - (\widetilde{p}_j^{fr} - w_j - c_j)s_j(\widetilde{\mathbf{p}}^{fr})\right]$$

because first order conditions determine retail margins $(p_s - w_s - c_s)$ at equilibrium, and out of equilibrium retail margins $(\widetilde{p}_j^{fr} - w_j - c_j)$ in case r refuses the offer of f.

Remark that when participation constraints are binding, we cannot identify fixed fees that depend on exogenously fixed reservation profits $\overline{\Pi}^r$.

3.2.2 *With Resale Price Maintenance*

Let's consider the case where manufacturers use resale price maintenance (RPM) in their contracts with retailers. Then, manufacturers can choose retail prices while the wholesale prices have no direct effect on profit. In this case, the vectors of prices $\widetilde{\mathbf{p}}^{fr}$ are such that $\widetilde{p}_i^{fr} = p_i$ if $i \notin G_{fr}$ and the profit (13) of manufacturer f can then be written as[4]

$$\Pi^f = \sum\nolimits_{j\in G_f}(w_j - \mu_j)s_j(\mathbf{p}) + \sum\nolimits_{j=1}^{J}(p_j - w_j - c_j)\left[s_j(\mathbf{p}) - s_j(\widetilde{\mathbf{p}}^{fr(j)})\right]$$

Remark that with RPM, the previous expression of the manufacturer profit can be written

$$\Pi^f = \sum_{j\in G_f}((p_j - \mu_j - c_j)s_j(\mathbf{p}) + \sum_{j\notin G_f}(p_j - w_j - c_j)s_j(\mathbf{p}) - \sum_{j=1}^{J}(p_j - w_j - c_j)s_j(\widetilde{\mathbf{p}}^{fr(j)})$$

[4] Because also $s_s(\widetilde{\mathbf{p}}^{fr(s)}) = 0$, $\widetilde{p}_s^{fr} = +\infty$ for $s \in G_{fr}$ and by convention $s_s(\widetilde{\mathbf{p}}^{fr(s)})\widetilde{p}_s^{fr} = 0$.

where the part $\sum_{j\in G_f}(p_j-\mu_j-c_j)s_j(\mathbf{p})+\sum_{j\notin G_f}(p_j-w_j-c_j)s_j(\mathbf{p})$ is the expression of the profit when there is no incentive constraint and thus the buyer power corresponds to the rent $\sum_{j=1}^{J}(p_j-w_j-c_j)s_j(\widetilde{\mathbf{p}}^{fr(j)})=\sum_{j\notin G_f}(p_j-w_j-c_j)s_j(\widetilde{\mathbf{p}}^{fr(j)})$ (because $s_j(\widetilde{\mathbf{p}}^{fr(j)})=0$ if $j\in G_f$) that the manufacturer has to leave to the retailer. With RPM, we see that this "endogenous" rent that the manufacturer f has to leave to the retailer r ($\sum_{j\notin G_f}(p_j-w_j-c_j)s_j(\widetilde{\mathbf{p}}^{fr(j)})$) is not affected by the retail prices on its own products decided using RPM because the vector $\widetilde{\mathbf{p}}^{fr(j)}$ corresponds to the vector of prices when firm f products are not sold by retailer r and thus is not affected by retail prices of firm f products but only by competing manufacturers choices of prices.

Now, we can use the first order conditions of the maximization of profit of f with respect to retail prices $p_j\in G_f$ which are :

$$0=s_j(\mathbf{p})+\sum_{k=1}^{J}\left[(p_k-w_k-c_k)\frac{\partial s_k(\mathbf{p})}{\partial p_j}\right]+\sum_{k\in G_f}(w_k-\mu_k)\frac{\partial s_k(\mathbf{p})}{\partial p_j}$$

As Rey and Vergé (2010) argue, a continuum of equilibria exist in this general case with RPM, with one equilibrium corresponding to each possible value of the vector of wholesale prices $\mathbf{w}$.

As we can re-write the retail margins $(\mathbf{p}-\mathbf{w}-\mathbf{c})$ as the difference between total margins $(\mathbf{p}-\boldsymbol{\mu}-\mathbf{c})$ and wholesale margins $(\mathbf{w}-\boldsymbol{\mu})$, the previous $J-J^{'}$ first order conditions can be written in a matrix form as

$$I_f s(\mathbf{p})+I_f S_p(\mathbf{p})(\boldsymbol{\gamma}+\boldsymbol{\Gamma})-I_f S_p(\mathbf{p})(I-I_f)\boldsymbol{\Gamma}=0 \qquad (18)$$

where $\boldsymbol{\Gamma}=\left(w_j-\mu_j\right)_{j=1,..,J}$ is the full vector of wholesale margins and $\boldsymbol{\gamma}+\boldsymbol{\Gamma}$ the vector of total margins.

The previous equations stand for the pricing of brands owned by manufacturers who retail their products through a downstream intermediary. Private labels (store brands) pricing obviously does not follow the same pricing equilibrium. However the retailers' profits coming from private labels are implicitly taken into account in the incentive and participation constraints of retailers when manufacturers make take-it-or-leave-it offers. Taking into account the possibility of endogenous entry and exit of private label products by retailers is out of the scope of this paper.

Thus, in the case of private label or store brand products, retailers choose retail prices and bear the marginal cost of production and distribution, solving :

$$\max_{\{p_j\}_{j\in\widetilde{S}_r}} \sum\nolimits_{j\in\widetilde{S}_r}(p_j-\mu_j-c_j)s_j(\mathbf{p})+\sum\nolimits_{j\in S_r\backslash\widetilde{S}_r}(p_j-w_j-c_j)s_j(\mathbf{p})$$

where $\widetilde{S}_r$ is the set of private label products of retailer r. The first order conditions of the profit maximization of retailers give

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

which can be written

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

These conditions clearly show that wholesale prices on manufacturer brands also affect the pricing conditions of store brands.

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

$$\widetilde{I}_r s(\mathbf{p})+(\widetilde{I}_r S_p(\mathbf{p})I_r)(\boldsymbol{\gamma}+\boldsymbol{\Gamma})-\widetilde{I}_r S_p(\mathbf{p})I_r\boldsymbol{\Gamma}=0 \tag{19}$$

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

We thus obtain the following system of equations with (18) and (19) where $\boldsymbol{\gamma}$ and $\boldsymbol{\Gamma}$ are unknown :

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

After solving the system (see appendix 6.3), we obtain the expression for the total price-cost margin of all products as a function of demand parameters, of the structure of the industry and the vector $\boldsymbol{\Gamma}$ of wholesale margins :

$$\begin{aligned} \boldsymbol{\gamma}+\boldsymbol{\Gamma} \quad = \quad & -\left(\sum\nolimits_r I_r S_p'(\mathbf{p})\widetilde{I}_r S_p(\mathbf{p})I_r+\sum\nolimits_f S_p'(\mathbf{p})I_f S_p(\mathbf{p})\right)^{-1} \\ & \left(\sum\nolimits_r I_r S_p'(\mathbf{p})\widetilde{I}_r\left[s(\mathbf{p})-S_p(\mathbf{p})I_r\boldsymbol{\Gamma}\right]+\sum\nolimits_f S_p'(\mathbf{p})I_f\left[s(\mathbf{p})-S_p(\mathbf{p})(I-I_f)\boldsymbol{\Gamma}\right]\right) \end{aligned} \tag{20}$$

Thus, there is a continuum of equilibria depending on the vector of wholesale prices $\mathbf{w}$ which prevents the full identification of price-cost margins without further restriction. In the absence of store brands, this would simplify to

$$\boldsymbol{\gamma} + \boldsymbol{\Gamma} = -\left(\sum\nolimits_f S_p'(\mathbf{p}) I_f S_p(\mathbf{p})\right)^{-1} \left(\sum\nolimits_f S_p'(\mathbf{p}) I_f \left[s(\mathbf{p}) - S_p(\mathbf{p})(I - I_f)\boldsymbol{\Gamma}\right]\right)$$

Contrary to the previous case without RPM, identification then requires additional restrictions. Actually, with J products and T markets, we have JT marginal costs of distribution and JT marginal costs of production that are unknown, or equivalently JT retailer margins and JT manufacturer margins. Thus, $2JT$ parameters have to be identified while our structural model gives a system of JT equations. Then, identification cannot be obtained unless additional restrictions are imposed.

We consider several possible restrictions, from very strong ones imposing zero wholesale or retail margins to a general case with a less restrictive one.

Zero wholesale margins : Fixing the vector of wholesale margins Γ_t to zero is sufficient to get identification of total margins and thus also retail and wholesale margins which are zero in this case. This corresponds to the particular equilibrium where wholesale prices are such that $w_{jt}^* = \mu_{jt}$ for all j, t that is $\Gamma_t = 0$, $\forall t$. Simplifying (20), it implies that

$$\gamma_t = -\left(\sum\nolimits_r I_r S_p' \widetilde{I}_r S_p I_r + \sum\nolimits_f S_p' I_f S_p\right)^{-1} \left(\sum\nolimits_r I_r S_p' \widetilde{I}_r + \sum\nolimits_f S_p' I_f\right) s(p_t) \tag{21}$$

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

$$\gamma_t = -S_p^{-1} s(p_t) \tag{22}$$

because then $\sum_f I_f = I$ and $\widetilde{I}_r = 0$.

This shows that two part tariffs contracts with RPM allow to maximize the full profits of the integrated industry if retailers have no private label products, the buyer power of retailers shifting simply the rent between parties[5].

Zero retail margins : When wholesale prices are such that the retailer's price-cost margins are zero ($p^*_{jt}(w^*_{jt}) - w^*_{jt} - c_{jt} = 0$ that is $\gamma_{ft} = 0$ for all f), then the first order conditions give the simplified expression of wholesale margins as

$$\Gamma_{ft} = (p_t - \mu_t - c_t) = -(I_f S_p I_f)^{-1} I_f s(p_t) \tag{23}$$

for all $f = 1, .., F$. For private label products, denoting $\gamma^{pl}_{rt} + \Gamma^{pl}_{rt}$ the vector of total price-cost margins of private labels of retailer r, we have

$$\gamma^{pl}_{rt} + \Gamma^{pl}_{rt} = -(\widetilde{I}_r S_p \widetilde{I}_r)^{-1} \widetilde{I}_r s(p_t)$$

All margins are then identified.

General case : A less restrictive identification method may consist in adding restrictions on the vectors of marginal costs or margins. Actually, (20) defines a known mapping $H(.)$ between the vector of total margins $(\Gamma_t + \gamma_t)$ and wholesale margins (Γ_t) for market t, as

$$(\Gamma_t + \gamma_t) = H(\Gamma_t)$$

where $H(.)$ depends only on the demand shape and the structure of the industry.

Thus, there exists a one to one correspondence between the vector of unknown JT parameters Γ_{jt} and the vector of unknown JT total marginal costs denoted C_{jt} because

$$C_{jt} \equiv \mu_{jt} + c_{jt} = p_{jt} - \left(\Gamma_{jt} + \gamma_{jt}\right) = p_{jt} - H_j(\Gamma_t) \text{ for all } j = 1, .., J \text{ and } t = 1, .., T$$

where H_j denotes the j^{th} row of H.

Then, adding some cost function restrictions, we can get identification of retail and wholesale margins in two-part tariffs models with RPM. Of course these additional identifying restrictions

[5] Rey and Vergé (2010) showed that, among the continuum of possible equilibria, the case where wholesale prices are equal to the marginal costs of production is the equilibrium that would be selected if retailers can provide a retailing effort that increases demand. In this case, if the manufacturer allows the retailer to be the residual claimant of his retailing effort, it leads to select wholesale prices equal to marginal costs of production.

are not without loss of generality but it happens that some natural restrictions appear in the case of differentiated products models. We thus consider the following assumption :

Identification assumption : there is a set of observed variables Z_{jt} and a known function $f(.,\theta)$ with finite dimensional parameter $\theta \in \Theta$ such that for all $j = 1,..,J$ and $t = 1,..,T$

$$C_{jt} = f(Z_{jt},\theta) + \zeta_{jt} \text{ with } E\left(\zeta_{jt}|Z_{jt}\right) = 0 \tag{24}$$

Then, we can use this assumption to identify the set of parameters (Γ,θ) that satisfy the moment condition

$$E\left(\zeta_{jt}\left(\Gamma,\theta\right)\right) = 0 \tag{25}$$

where

$$\zeta_{jt}\left(\Gamma,\theta\right) = p_{jt} - H_j(\Gamma_t) - f(Z_{jt},\theta)$$

As $\nabla_\theta \zeta_{jt}\left(\Gamma,\theta\right) = -\nabla_\theta f(Z_{jt},\theta)$ and $\nabla_\Gamma \zeta_{jt}\left(\Gamma,\theta\right) = -\nabla_\Gamma H_j(\Gamma_t)$ where $H_j(\Gamma_t)$ is given by (20) we know that we will get identification depending on the cost restrictions and on $H_j(.)$ (the j^{th} row of H which depends on the demand shape) if the Jacobian matrix of $E\left[\zeta_{jt}\left(\Gamma,\theta\right)\right]$, that is $E\left[\nabla_\Gamma \zeta_{jt}\left(\Gamma,\theta\right), \nabla_\theta \zeta_{jt}\left(\Gamma,\theta\right)\right]$, has full rank. This condition depends on the shape of the demand and the structure of the industry. Actually, the gradient $\nabla_\Gamma H_j(\Gamma)$ can be written (using I_j for the matrix that is zero everywhere except equal to one on the (j,j) element)

$$\begin{aligned}\nabla_\Gamma H_j(\mathbf{\Gamma}) &= I_j\left(\sum\nolimits_r I_r S_p'(\mathbf{p})\widetilde{I}_r S_p(\mathbf{p}) I_r + \sum\nolimits_f S_p'(\mathbf{p}) I_f S_p(\mathbf{p})\right)^{-1} \\ &\quad \left(\sum\nolimits_r I_r S_p'(\mathbf{p})\widetilde{I}_r\left[S_p(\mathbf{p}) I_r\right] + \sum\nolimits_f S_p'(\mathbf{p}) I_f\left[S_p(\mathbf{p})(I - I_f)\right]\right)\end{aligned}$$

which in general has no reason to be colinear with $\nabla_\theta f(Z_{jt},\theta)$. It is however enlightening to look at specific cases.

If we don't have store brands, we can simplify the above expression to

$$\nabla_\Gamma H_j(\mathbf{\Gamma}) = I_j\left(\sum\nolimits_f S_p'(\mathbf{p}) I_f S_p(\mathbf{p})\right)^{-1}\left(\sum\nolimits_f S_p'(\mathbf{p}) I_f\left[S_p(\mathbf{p})(I - I_f)\right]\right)$$

which has also no reason to be colinear with $\nabla_\theta f(Z_{jt},\theta)$. In the case where we have a manufacturer in monopoly situation, then $(\boldsymbol{\gamma} + \mathbf{\Gamma}) = -S_p(\mathbf{p})^{-1} s(\mathbf{p})$ and $\nabla_\Gamma(\boldsymbol{\gamma} + \mathbf{\Gamma}) = \mathbf{0}$ (because $I_f = I$) In which case, unsurprisingly, wholesale margins have no impact on total margins (and prices) since the manufacturer uses two part tariffs contracts to capture all the retailers rents and wholesale prices have no impact on the equilibrium.

Then, we can also remark that the restriction on the function $f(.,\theta)$ can imply a restriction on margins if for example $Z_{jt}=(\tilde{Z}_{jt},p_{jt})$ and we impose for some $g(.,\theta)$ that $f(Z_{jt},\theta)=g(\tilde{Z}_{jt},\theta)p_{jt}$.

Finally, remark that some "natural" restrictions on the cost function arise from the additive structure of total marginal cost between marginal cost of production and distribution. For example, one could consider that the marginal cost of production μ_{jt} should depend only on the brand of product j, meaning that the same brand sold in two different retailers should have the same marginal cost of production. One could also consider that the marginal cost of distribution c_{jt} for product j should depend only on the retailer identity and not on the brand. Thus without even adding restrictions across markets but simply restrictions across differentiated products it would be natural to impose that $C_{jt}=\mu_{jt}+c_{jt}=\mu_{b(j)t}+c_{r(j)t}$ where $b(j)$ denotes the brand index of product j and $r(j)$ denotes the retailer index of product j. Such restriction would reduce the degree of underidentification of margins since it adds $J=B*R$ restrictions and only $B+R$ additional unknown parameters. The true degree of underidentification will depend on the properties of the non linear function $H(.)$.

Then, once margins have been identified, one can identify the sum of fixed fees paid by any retailer to any manufacturer using the fact that with RPM

$$\begin{aligned}
\sum_{j\in G_{fr}} F_s &= \sum_{j\in S_r}(p_j-w_j-c_j)s_j(\mathbf{p})-\sum_{j\in S_r\backslash G_{fr}}(p_j-w_j-c_j)s_j(\widetilde{\mathbf{p}}^{fr}) \\
&= \sum_{j\in G_{fr}}(p_j-w_j-c_j)s_j(\mathbf{p})+\sum_{j\in S_r\backslash G_{fr}}(p_j-w_j-c_j)\left[s_j(\mathbf{p})-s_j(\widetilde{\mathbf{p}}^{fr})\right]
\end{aligned}$$

where $\widetilde{p}_j^{fr}=p_j$ for $j\in S_r\backslash G_{fr}$ since RPM is used by all manufacturers which implies that retail prices will not depend on the fact that some retailer has refused some manufacturer's offer, but $s_j(\mathbf{p})\neq s_j(\widetilde{\mathbf{p}}^{fr})$ if $j\in S_r\backslash G_{fr}$ because of substitutions in demand to other products when products G_{fr} are not in shelves (because refusal by retailer r of firm f products), and because by convention

$s_j(\widetilde{\mathbf{p}}^{fr}) = 0$ for $j \in G_{fr}$.

Finally, when participation constraints are binding, one cannot identify fixed fees because

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

where $\overline{\Pi}^r$ is unknown. In this case, only "variable" margins and marginal costs can possibly be identified. Profits of retailers and manufacturers are identified up to a constant which is exogenous to the horizontal and vertical competition game.

4 Econometric Estimation and Empirical Results

We now turn to the empirical estimation and tests by first showing how we identify the demand independently from any assumption on the supply side (using individual consumer data but that we could have done it with aggregate data as in Nevo (2001)). We then present the estimation and tests of the supply side models and contracts using the demand estimates.

4.1 A Random Coefficients Logit Demand Model

We use a standard discrete choice model of consumer behavior following Berry (1994), Berry, Levinsohn and Pakes (1995) and estimate this random coefficient logit model on individual choices as in Revelt and Train (1998). It is well known that random coefficients logit models are very flexible (McFadden and Train, 2000) and are not as restrictive on own and cross-price elasticities as a simple logit model thanks to the allowing of heterogeneity of preferences on individual purchase choices. Thus, we assume that the indirect utility function of a consumer i buying product j at t is

$$U_{ijt} = \beta_{b(j)} + \beta_{r(j)} + \delta_i X_j - \alpha_i p_{jt} + \xi_{ijt} \tag{26}$$

where $\beta_{b(j)}$ represents a brand time invariant specific effect on utility, $\beta_{r(j)}$ represents a retailer time invariant specific effect, X_j is a dummy variable which is equal to 1 if the product j is a mineral water and 0 otherwise (some brands have both versions which allows identification of the mean effect of δ_i in addition to its variance), p_{jt} is the price of product j at period t, and ξ_{ijt} is an additive separable deviation from the mean utility. The random coefficient α_i represents the unobserved marginal disutility of income for consumer i. We assume that $\alpha_i = \alpha + \sigma^\alpha v_i^\alpha$ where v_i^α is distributed standard normal and σ^α characterizes how consumer marginal utility of income deviates from the mean. We also assume that consumers have different tastes δ_i for the mineral water versus spring water characteristic. Hence, we write $\delta_i = \delta + \sigma^\delta v_i^\delta$ where v_i^δ is distributed standard normal.

The model is completed by the inclusion of an outside good, denoted good zero, allowing consumer i not to buy one of the J marketed products during period t. The mean utility of the outside good is normalized to zero implying that the consumer indirect utility of choosing the outside good is $U_{i0t} = \xi_{i0t}$.

As some product characteristics might be omitted in the specification of utility (26), like for instance, product advertising, and be correlated with prices, we follow Petrin and Train (2010) which proposes a control function approach to solve this endogeneity problem of prices. This method consists in estimating a first stage regression of prices on observed cost shifters as follows :

$$p_{jt} = \lambda_{b(j)} + \lambda_{r(j)} + \lambda X_j + \gamma W_{jt} + \eta_{jt}$$

where $\lambda_{b(j)}$ and $\lambda_{r(j)}$ are respectively brand and retailer specific effects, W_{jt} represents a vector of observed possible cost shifters (like input prices or product characteristics), X_j some observed time invariant product characteristics and η_{jt} is a random shock defined as the residual of the orthogonal projection of p_{jt} on $\lambda_{b(j)}$, $\lambda_{r(j)}$, W_{jt}. Then, introducing η_{jt} in the specification of the consumer utility U_{ijt} makes the assumption of orthogonality of the residual consumer utility deviations with price more plausible. This method amounts to assume that the consumer utility can be written as follows :

$$U_{ijt} = \beta_{b(j)} + \beta_{r(j)} + \delta_i X_j - \alpha_i p_{jt} + \tau \eta_{jt} + \varepsilon_{ijt}$$

where by definition $\xi_{ijt} = \tau \eta_{jt} + \varepsilon_{ijt}$ with the assumption that ε_{ijt} is orthogonal to p_{jt}. With this random utility, we assume that consumer i chooses alternative j^* if $U_{ij^*t} \geq U_{ijt}$ for all $j = 1, .., J$ and $U_{ij^*t} > U_{ijt}$ for some j.

This method allows to estimate consistently the demand price elasticities even if time varying unobserved characteristics (correlated with η_{jt}) affect consumer tastes and are correlated with price (like advertising), provided that the residual or the projection of these unobservables on η_{jt} be uncorrelated with the price p_{jt}.

Then, we assume that the idiosyncratic taste shocks ε_{ijt} are independently and identically distributed according to a Gumbel (extreme value type 1) distribution, so that the consumer i choice probability L_{ijt} of buying j at period t conditional on α_i, δ_i and $\boldsymbol{\beta}$ is :

$$L_{ijt}(\alpha_i, \delta_i, \boldsymbol{\beta}) = \frac{\exp(V_{ijt})}{1 + \sum_{k=1}^{J} \exp(V_{ikt})}$$

where $V_{ijt} = \beta_{b(j)} + \beta_{r(j)} + \delta_i X_j - \alpha_i p_{jt} + \tau \eta_{jt}$.

Then, the unconditional probability of the observed sequence of T choices for consumer i is

$$P_i(\alpha, \sigma^\alpha, \delta, \sigma^\delta, \boldsymbol{\beta}) = \int \left(\prod_{t=1}^{T} L_{ij^*(i,t)t}(\alpha_i, \delta_i, \boldsymbol{\beta}) \right) f(\alpha_i | \alpha, \sigma^\alpha) f(\delta_i | \delta, \sigma^\delta) d\alpha_i d\delta_i$$

where $\boldsymbol{\beta}$ is the vector of all β_b, β_r and τ parameters in (26), $j^*(i,t)$ is the chosen alternative by consumer i at period t and $f(\alpha_i|\alpha, \sigma^\alpha)$ and $f(\delta_i|\delta, \sigma^\delta)$ are the p.d.f. of the random coefficients α_i and δ_i respectively assumed independent.

We use simulated maximum likelihood to estimate the model parameters (Train, 2009), maximizing

$$SLL(\alpha, \sigma^\alpha, \delta, \sigma^\delta, \boldsymbol{\beta}) = \sum_{i=1}^{N} \ln \left[\frac{1}{R} \sum_{r=1}^{R} \left(\prod_{t=1}^{T} L_{ij(i,t)t}(\alpha^r, \delta^r, \boldsymbol{\beta}) \right) \right]$$

with respect to $\alpha, \sigma^\alpha, \delta, \sigma^\delta, \boldsymbol{\beta}$ and where R is the number of simulations, α^r and δ^r are the r^{th} Halton draws of the distributions $f(\alpha_i|\alpha, \sigma^\alpha)$ and $f(\delta_i|\delta, \sigma^\delta)$ respectively.

The random coefficients logit model generates a flexible pattern of substitutions between products. Consumers have different price disutilities that will be averaged to a mean price sensitivity and cross-price elasticities are not constrained by the individual level logit assumption. Once the demand parameters have been estimated, the aggregate market shares and price elasticities of the demand can be obtained by simulation and used for the estimation of price-cost margins using the different supply models presented in section 3.

4.2 Demand Estimation Results

Using the data described in section 2.2, we have constructed observations of the households choices of bottles of water over 13 periods of 4 weeks in 2006 using each purchase. In case of multiple purchases within a period, we randomly draw a product purchased during each period. Doing such aggregation is however not essential for the results found. The household purchase data finally allows to construct a sample of 2,836 households present over the whole 13 periods that is 36,868 observations. We have removed households not present in the survey for more than 6 months in 2006 and also removed observations for which missing values exist in some variables. The demand estimation results of the random coefficient logit as well as a simple multinomial logit are presented in Table 2.

Table 2 : Estimation Results of Demand Models[6]

	Multinomial Logit	Random Coefficients Logit
Coefficients	(1)	(2)
Price ($-\alpha$)	-18.76 (0.421)	-20.33 (0.427)
Price (σ^{α})		6.42 (0.1665)
Mineral water (δ)	1.28 (0.087)	3.48 (0.1174)
Mineral water (σ^{δ})		3.83 (0.1041)
Control $\widehat{\eta}_{jt}$ (τ)	17.06 (0.474)	15.85 (0.5222)
Brand 1	3.01 (0.089)	3.20 (0.1054)
Brand 2	5.08 (0.125)	5.48 (0.1316)
Brand 3	1.86 (0.083)	1.99 (0.0949)
Brand 4	0.97 (0.068)	1.28 (0.0744)
Brand 5	2.25 (0.072)	2.81 (0.0728)
Brand 6	0.88 (0.052)	0.69 (0.0507)
Retailer 1	0.15 (0.072)	0.36 (0.0637)
Retailer 2	0.69 (0.074)	0.92 (0.0626)
Retailer 3	0.02 (0.078)	0.25 (0.0742)
Retailer 4	0.45 (0.071)	0.62 (0.0730)
Retailer 5	0.90 (0.068)	0.11 (0.0635)
Retailer 6	-0.17 (0.092)	0.03 (0.0824)

Notes : Bootstrap standard errors in parenthesis (100 replications).

The results show that the price coefficient has the expected sign. In the case of the random coefficient logit model, the price coefficient has a normal distribution with mean equal to -20.33 and standard deviation σ^{α} equal to 6.42 which means that only 0.07% of the distribution of

[6] Remark that we cannot provide the names of brand and retailer chains using these Kantar proprietary data.

the coefficient α_i has the wrong sign. The mean taste of the mineral characteristic is positive which means that consumers like mineral waters. Only 17.6% do not like it. In the multinomial or random coefficient logit model, the parameter τ of the control term η_{jt} (obtained from a first stage price regression shown in Appendix 6.2) is significantly positive showing that, on one hand, some correlation existed between prices and unobserved product characteristics included in the error term ξ_{ijt} and these unobserved characteristics would enter positively in the utility function. We would expect that product advertising increases the consumer utility and is also positively correlated with price, giving an interpretation to this control function approach as in Petrin and Train (2010).

Once we obtained demand estimates, we can compute price elasticities of demand for these differentiated products. We obtain for each market (period) a large set of own and cross price elasticities for the 56 differentiated products, that are summarized in Table 3. Table 3 presents the average own and cross price elasticities by brand obtained with the estimates of the random coefficients logit model. Separating mineral waters from spring waters, we can observe that mineral waters have on average larger own price elasticities (-6.7 on average versus -3.09). Moreover, cross price elasticities of mineral waters with respect to spring waters are smaller than with respect to other mineral waters and it is also true that spring waters are also more substitute among themselves than across type of waters. Store brands correspond to brands 7 and 8 and on average have smaller cross price elasticities that manufacturers' brands.

Table 3 : Average Own an Cross Price Elasticities by brand

	Type	Brand 1	Brand 2	Brand 3	Brand 4	Brand 5	Brand 6	Brand 7	Brand 8
Brand 1	MW	-6.6645	0.0607	0.0822	0.0843	0.0798	0.0211	0.0896	0.0205
Brand 2	MW	0.1193	-7.7233	0.1134	0.1024	0.1154	0.0276	0.0978	0.0319
Brand 3	MW	0.0888	0.0731	-6.1269	0.0937	0.0889	0.0240	0.0989	0.0239
Brand 4	MW	0.1392	0.1108	0.1461	-5.6400	0.1457	0.0382	0.1563	0.0375
Brand 5	MW	0.1466	0.1281	0.1607	0.1635	-6.3078	0.0411	0.1705	0.0408
Brand 6	SW	0.0175	0.0172	0.0174	0.0174	0.0175	-2.4515	0.0174	0.0539
Brand 7	MW	0.0535	0.0354	0.0590	0.0688	0.0600	0.0173	-4.9186	0.0145
Brand 8	SW	0.0261	0.0213	0.0278	0.0291	0.0275	0.0856	0.0314	-3.0484

Notes : Each cell element represents the average elasticity of products of the brand in row w.r.t. products of brand in column. Average over all products by brand and markets (periods). MW means mineral water and SW means spring water.

4.3 Estimation of Price-Cost Margins

Once one has estimated the demand parameters, we can use the supply models described in section 3 to compute the price-cost margins at the retailer and manufacturer levels for all products, under the various classes of models considered. As we have seen, margins are identified in all supply side models without cost side assumptions except in the case of two part tariffs contracts with RPM, where the identification of margins can only be obtained under additional cost side restrictions that we describe here.

Indeed, in the case of two part tariffs contracts with RPM, we use a specific form of the cost side restriction (24) where we assume that there exists $B+R$ parameters λ_b, Λ_r such that

$$C_{jt} = \mu_{jt} + c_{jt} = f(\lambda_{b(j)} + \Lambda_{r(j)})p_{jt} + \zeta_{jt} \text{ for all } j = 1,..,J \text{ and } t = 1,..,T \tag{27}$$

where ζ_{jt} is an uncorrelated shock and $f(.)$ is such that $f(x) = (1+\exp(x))^{-1}$ (which proved to be the preferred empirical specification among several others). This assumption means that the expected total marginal cost C_{jt} is a share of retail price p_{jt} which is non time varying, brand and retailer specific. Then, using the moment condition (25) we are able to identify all parameters and margins which amounts in this particular case to solve the minimization problem

$$\min_{\{\Gamma_t\}_t, \{\lambda_b, \Lambda_r\}_{b,r}} \sum\nolimits_{j,t} \left[p_{jt} - H_j(\Gamma_t) - f(\lambda_{b(j)} + \Lambda_{r(j)})p_{jt}\right]^2 \tag{28}$$

where the mapping $H(.)$ is given by (20). Remark that it remains an empirical question whether this moment condition will point identify all parameters, as it will always depend on the empirical shape of the mapping $H(.)$ and on the cost restriction. Using inequality restrictions on the cost structure would be an alternative using the framework of Pakes et al. (2015).

Table 4 shows the averages of the product level price-cost margins under the different models considered. Model 1 concerns the case of linear pricing. In order to save space, variants of linear pricing models are not presented although they have been estimated. As in Sudhir (2001), we estimated linear pricing models with collusion between manufacturers and/or retailers or assuming that retailers act as pass-through agents of marginal cost of production. All these models are finally strongly rejected and thus not shown. We also consider several non linear contracting models. Models 2, 3, 4 and 5 correspond to two part tariffs contracts with resale price maintenance. Remind that, in this case, whether the retailers can use competing offers to increase their buyer power when dealing with manufacturers does not change the pricing equilibrium but only the unobserved and unidentified fixed fees which determine the sharing of the rent in the vertical structure. Thus, these estimation results are consistent with a model where either the buyer power is endogenous or exogenous in the vertical relationship (that is when the participation constraints are binding or not). Model 2 is the general case (20) where the equilibrium wholesale margins are estimated using an additional restriction (27) on total margins across products and markets. Model 3 corresponds to the case where no wholesale price discrimination is imposed. In this model, manufacturers are prevented to sell a given product to different retailers at different prices which implies that the wholesale price of any product j depends only on its brand $b(j)$ and not on the retailers identity $r(j)$. These restrictions are incorporated in the estimation of margins using (28) where the vector of unknowns Γ is constrained to uniform wholesale pricing. The results of the estimation of models 2 and 3 show retail, wholesale and total margins obtained from this estimation (remind that for private labels, total margins are equal to retail margin by convention and thus on average total margins are lower than the sum of average retail and wholesale margins). In Model 4, we assume that wholesale prices are equal to the marginal cost of production which corresponds to the case of equation (21). Model 5 is the case where the wholesale prices are such that the retailers' margins are zero. Finally, models 6 and 7 are the case of two part tariffs contracts without resale price maintenance either with exogenously determined buyer power (model 6) or with endogenously determined buyer power (model 7).

Table 4 : Estimation Results of Price-Cost Margins

Price-Cost Margins (% of retail price p_{jt})		Mineral Water Mean	Mineral Water Std.	Spring Water Mean	Spring Water Std.
Linear Pricing (Double Marginalization)					
Model 1	Retailers	16.93	2.36	36.56	6.92
	Manufacturers	23.35	4.14	44.12	5.98
	Total	36.39	8.40	58.62	27.48
Two part Tariffs with RPM					
Model 2	General wholesale prices (w_{jt}) with restriction (27)				
	Retailers	49.05	23.49	45.95	36.69
	Manufacturers	5.25	21.43	21.43	41.14
	Total	54.30	14.51	67.38	33.62
Model 3	No wholesale price discrimination ($w_{b(j)t}$) with restriction (27)				
	Retailers	61.46	17.18	29.72	8.77
	Manufacturers	0.00	0.00	44.32	45.47
	Total	61.46	17.18	74.04	39.53
Model 4	Manufacturer marginal cost pricing ($w = \mu$)	66.32	19.08	78.18	41.04
Model 5	Zero retail margin ($p = w + c$)	25.53	5.07	43.39	14.40
Two-part Tariffs without RPM					
Exogenous Retail Buyer Power					
Model 6	Retailers	16.93	2.36	36.56	6.92
	Manufacturers	18.75	3.88	25.76	3.99
	Total	32.56	6.58	49.44	18.21
Endogenous Retail Buyer Power					
Model 7	Retailers	16.93	2.36	36.56	6.92
	Manufacturers	21.71	6.39	49.53	13.71
	Total	35.03	8.77	61.33	31.26

Notes : Means and standard deviations of margins across products and periods[7]

Interestingly, Table 4 shows that estimated margins are always between 0 and 100%, which is not a constraint imposed by the supply model estimated. However, margins do vary a lot across models. Margins vary also across products but on average, we find that total price-cost margins in percentage of retail price are lower for mineral water than for spring water but the share between retail and wholesale varies substantially across models. Remind also that in the case of two part tariffs models, Table 4 does not show the estimated fixed fees but only the retail and wholesale margins that don't take into account the transfers between parties that can be positive or negative, as we will show later in section 4.5.

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

4.4 Testing Across Models

Then, in order to test between alternative models of price-cost margins estimated, we apply non nested tests *à la* Vuong (1989) and Rivers and Vuong (2002). They allow to draw some inference between any two alternative models for which we obtained total marginal costs. The tests statistics are based on the difference between the lack-of-fit criterion of each cost equation that can be estimated for each model once price-cost margins are obtained and some cost restrictions are applied (see statistical details about the test in Appendix 6.4).

Indeed, after estimating the different price-cost margins for the models considered, one can recover the total marginal cost C_{jt}^h as the difference between observed price and total margin. Remark that for all models, except models 2 and 3, we have not used any restriction on the marginal costs to identify margins. In the case of models 2 and 3, we have used cost restrictions in order to identify margins within the class of these models where manufacturers propose two part tariffs contracts with resale price maintenance. Thus, in order to test across models, including the models 2 and 3, we use different cost restrictions that consist in using observed cost shifters and thus project cost estimates in a different space so that the cost restrictions (27) imposed to identify models 2 and 3 can be consistent with the other restrictions we now impose.

For such tests, we specify cost equations as follows, for models $h = 1, ..., 7$:

$$\ln C_{jt}^h = \pi^h W_{jt} + \omega_{m(j)}^h + \omega_{r(j)}^h + \eta_{jt}^h$$

where variables W_{jt} include interactions between product characteristics such as dummy variable for spring water and mineral water and cost variables such as wages, and plastic price variables (obtained from the French National Institute for Statistics and Economic Studies (INSEE)), π^h are associated parameters, ω_r^h are retailer fixed effects and ω_m^h are manufacturer fixed effects. Actually, it is likely that labor costs and plastic price (which is the major component of bottles and packaging) are important determinants of variable costs. Moreover, we use an interaction with product characteristics because we expect that the impact of input price variables vary between mineral and spring water (e.g., quality of plastic that may differ across products). Also, the relatively important variations of all these price indices over time suggests a potentially good identification of our cost equations. Table 5 presents the results of these cost equations estimated by OLS for the seven different models. Estimates of coefficients are shown except for the too many fixed effects coefficients for which we present F tests of joint significance.

Table 5 : Cost Equations for each Model

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Wage×SW	-0.16	-0.12	-0.05	-0.05	-0.16	-0.15	-0.65***
(Std. err.)	(0.22)	(0.28)	(0.26)	(0.26)	(0.25	(0.25)	(0.19)
Wage×MW	-0.08	-0.10	-0.06	-0.07	-0.06	-0.07	-0.60***
(Std. err.)	(0.23)	(0.31)	(0.30)	(0.31)	(0.25)	(0.26)	(0.22)
Plastic×SW	0.11	0.14***	0.14***	0.15***	0.11	0.12	0.15*
(Std. err.)	(0.00)	(0.06)	(0.06)	(0.06)	(0.07)	(0.07)	(0.07)
Plastic×MW	0.13	0.20	0.22*	0.23*	0.12	0.14	0.19***
(Std. err.)	(0.06)	(0.11)	(0.11)	(0.12)	(0.10)	(0.09)	(0.08)
All fixed effects ω_m^h, ω_r^h included are not shown							
F test $\left\{\omega_m^h = 0\right\}$	251.16	264.82	344.70	360.89	322.22	261.52	406.79
(p val.)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
F test $\left\{\omega_r^h = 0\right\}$	47.73	33.41	46.39	49.13	29.69	19.50	8.63
(p val.)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Notes : MW and SW are dummies for mineral water and spring water respectively.

We then perform the non nested test of Rivers and Vuong (2002). Results of the tests are provided in Table 6. When the test statistic is negative and below the critical value chosen (-1.64 for a 5% significance), it means that we reject H_1 in favor of H_2. When the test statistic is positive and above the critical value chosen (1.64 for a 5% significance), it means that we reject H_2 in favor of H_1. When the test statistic is between the two critical values (-1.64,1.64), it means that we cannot distinguish statistically H_1 from H_2.

Table 6 : Non Nested Tests Across Models

$T_n \rightarrow N(0,1)$						
$\diagdown$	H_2					
H_1	2	3	4	5	6	**7**
1	1.10	0.71	0.28	7.48	4.25	**-3.16**
2		-3.79	-4.99	14.22	9.33	**-2.51**
3			-5.47	13.72	10.01	**-2.37**
4				13.14	9.85	**-2.21**
5					-11.38	**-5.60**
6						**-3.99**

Notes : Test statistic of the hypothesis H_1 in column in favor of the hypothesis H_2 in row.

The statistics of test T_n show that the best model appears to be the model 7 meaning that manufacturers and retailers use two part tariffs contracts without resale price maintenance (RPM) and that the buyer power of retailers is affected endogenously by the contractual competition of manufacturers.

Thus, the preferred model on these data from 2006 is a model with two part tariff contract without RPM which is consistent with the regulation in place after the reform of the Galland act defining below cost pricing (Allain and Chambolle, 2011, Biscourp et al., 2013). Indeed, in 2005, the Galland act was replaced by another law in order to redefine resale at loss by retailers and prevent the use of high wholesale prices to implement RPM (Allain and Chambolle, 2011). Actually, RPM is in principle forbidden in France but the competition authority wisdom was that the Galland act (in force between 1996 and 2005) allowed manufacturers to implement RPM equilibrium (which is consistent with the evidence of Bonnet and Dubois, 2010). Indeed, the definition of thresholds for resale at loss did not take into account backward margins and only wholesale unitary list prices which could be set high to enforce minimum retail prices, while compensating retailers with backward margins. After 2005, this became impossible because the definition of minimum retail prices for resale at loss did include part of the backward margins. Recently, Biscourp et al. (2013) shown with reduced form regressions that this legislation, which had the same effect as allowing industry-wide price floors, affected prices in a way which is consistent with the theories on the anti-competitive effects of resale price maintenance in markets with interlocking relationships (Rey and Vergé, 2010). Our tests based on data post 2005 and thus after the change in regulation are the first evidence that the regulatory change indeed seems to have succeeded in avoiding manufacturers vertical contracting to mimic two part tariffs contracts with RPM.

Looking at average price-cost margins for this preferred model, Table 4 shows that the average price-cost margins are of 35.03% for mineral water and 61.33% for spring water. In absolute values, the price-cost margins are on average 0.13€ for mineral water and 0.09€ for spring water because mineral water is on average more expensive. For this preferred model, the average total price-cost margins for national brands is 48.2% while it is of 26.4% for private labels. Remark that the high average margin for national brands is largely due to the only spring water national brand for which the total margin is much larger than others[8]. Otherwise, national brands of mineral water have an average total margin of 39.05% with 16.39% for the retail margin and 22.66% for the wholesale margin. However, the share of these "variable" margins across the manufacturers and retailers only gives a partial picture of the contractual terms in the industry. Indeed, two part tariffs contracts also imply some fixed fees along the vertical chain that we report and discuss in the next section.

4.5 Fixed Fees and Profits

We now present the estimated fixed fees of the preferred model. As seen before, inference favors vertical contracts that take the form of two part tariffs contracts without resale price maintenance where fixed fees are determined by the buyer power of downstream retailers with respect to upstream manufacturers. Once we know the vertical contracting model (either by observation or using the inference based on cost restrictions proposed in section 4.4), the model allows to identify margins and fees without any further assumption but the identified demand shape.

Remark that we have now to use total demanded quantities instead of market shares for each s_{jt} which simply amounts to re-scale by the total market size M_t which is fixed such that the total sales of bottles of water in our sample are representative of the French market using the household consumer weights that allow our sample to be representative of the total French population.

As seen in section 3, removing time subscripts t for simplicity, we can identify the total fees paid by a retailer r to a manufacturer f using

$$\sum\nolimits_{j\in G_{fr}} F_j = \sum\nolimits_{j\in S_r} \left[(p_j - w_j - c_j)s_j(p) - (\widetilde{p}_j^{fr} - w_j - c_j)s_j(\widetilde{p}^{fr})\right]$$

For notational simplicity, we denote $F_{fr} \equiv \sum_{j\in G_{fr}} F_j$ the total fees paid by retailer r to manufacturer f (that could be negative if the manufacturer is paying the retailer some fixed transfer). Table 7 reports the average yearly total fixed fees F_{fr} for each manufacturer-retailer

[8] There is a unique spring water national brand on the market for which total margins are relatively large. This spring water comes from many springs located in different places in the country and is known to have thus low transportation costs, and to use low quality low cost packaging.

pair fr. We can see that total exchanged fees are substantial and mostly positive meaning that a retailer pays some fixed fees to manufacturers, except for retailer 2 who receives large fixed fees from all manufacturers and retailer 1 who gets also a large fixed fee from manufacturers 1 and 3. The heterogeneity of contractual terms comes from the market structure and market demand. Confidence intervals reported in Table 9 in appendix 6.1 and show that results clearly allow to identify fees that are significantly different from zero, either positive or negative.

Then, as we can identify all fixed fees as well as retail and wholesale margins, we can analyze the distribution of profits among the vertical and horizontal structure as follows. For a given retailer r, its profit Π^r is

$$\begin{aligned}
\Pi^r &= \sum_{j\in S_r}[(p_j - w_j - c_j)s_j(\mathbf{p})] - \sum_{j\in S_r} F_j \\
&= \sum_f \underbrace{\sum_{j\in G_{fr}}[(p_j - w_j - c_j)s_j(\mathbf{p})]}_{\equiv\Pi^r_{fr}\text{ : retail variable profits on } G_{fr} \text{ products}} - \underbrace{\sum_f F_{fr}}_{\text{fees paid by } r \text{ to manufacturers}} \\
&= \sum_f \Pi^r_{fr} - \sum_f F_{fr}
\end{aligned}$$

that is the sum over all manufacturers of retail variable profits obtained from products G_{fr} minus total fees paid to manufacturers. On the manufacturer side, its profit Π^f is

$$\begin{aligned}
\Pi^f &= \sum_{j\in G_f}[(w_j - \mu_j)s_j(\mathbf{p})] + \sum_{j\in G_f} F_j \\
&= \sum_r \underbrace{\sum_{j\in G_{fr}}[(w_j - \mu_j)s_j(\mathbf{p})]}_{\equiv\Pi^w_{fr}\text{ : wholesale variable profits on } G_{fr} \text{ products}} + \underbrace{\sum_r F_{fr}}_{\text{fees collected by } f \text{ from all retailers}} \\
&= \sum_r \Pi^w_{fr} + \sum_r F_{fr}
\end{aligned}$$

that is the sum over all retailers of wholesale variable profits obtained from products G_{fr} plus total fees received from retailers. Table 7 shows the average yearly values for all retailers, manufacturers and manufacturer-retailer pairs of the retail (Π^r_{fr}), wholesale (Π^w_{fr}) variable profits, fixed fees (F_{fr}) as well as total fees and finally total profits net of fixed fees[9]. Table 10 and 11 in appendix 6.1

[9] Confidence intervals of the wholesale and retail variable profits estimates are reported in Tables 10 and 11 in Appendix, so that interpretation of results should be done with caution and with confidence intervals.

report the confidence intervals for the manufacturer-retailer pairs of the retail (Π^r_{fr}), wholesale (Π^w_{fr}) variable profits.

Table 7 : Average Yearly Profits Decomposition for each Manufacturer and Retailer

		Manufacturer f			Totals by Retailer r		
Retailer r		1	2	3	Variable Profit $\sum_f \Pi^r_{fr}$	Total Fees $\sum_f F_{fr}$	Total Profit Π^r
	Π^w_{fr}	$7,159$	$23,829$	$4,009$			
1	Π^r_{fr}	$8,054$	$15,632$	$3,323$	$27,009$		$28,942$
	F_{fr}	$-1,672$	294	-555		$-1,933$	
	Π^w_{fr}	$14,326$	$38,775$	$6,389$			
2	Π^r_{fr}	$12,837$	$23,548$	$4,997$	$41,382$		$93,362$
	F_{fr}	$-18,910$	$-15,420$	$-17,650$		$-51,980$	
	Π^w_{fr}	$6,542$	$19,589$	$3,348$			
3	Π^r_{fr}	$6,654$	$12,121$	$2,708$	$21,483$		$17,803$
	F_{fr}	$1,087$	$1,378$	$1,215$		$3,680$	
	Π^w_{fr}	$8,777$	$26,631$	$4,387$			
4	Π^r_{fr}	$9,680$	$17,802$	$3,683$	$31,165$		$23,501$
	F_{fr}	$2,509$	$2,621$	$2,534$		$7,664$	
	Π^w_{fr}	$13,609$	$41,158$	$7,654$			
5	Π^r_{fr}	$16,880$	$31,075$	$6,790$	$54,745$		$49,651$
	F_{fr}	$3,271$	607	$1,216$		$5,094$	
	Π^w_{fr}	$4,415$	$13,232$	$1,956$			
6	Π^r_{fr}	$3,926$	$7,324$	$1,491$	$12,741$		$9,473$
	F_{fr}	$1,063$	$1,114$	$1,091$		$3,268$	
	Π^w_{fr}	$4,011$	$15,106$	$1,767$	$12,714$		
7	Π^r_{fr}	$3,404$	$7,869$	$1,441$			$9,726$
	F_{fr}	972	$1,016$	$1,000$		$2,988$	
Totals by manufacturer f							
Variable Profit $\sum_r \Pi^w_{fr}$		$58,839$	$178,320$	$29,510$			
Total Fees $\sum_r F_{fr}$		$-11,680$	$-8,390$	$-11,149$			
Total Profit Π^f		$47,159$	$169,930$	$18,361$			

Notes : Numbers are average per year in thousands of Euros.

Table 7 shows that fixed transfers can account for very variable shares of total profits with more than half of profit for the most profitable retailer chain who obtains substantial backward margins (negative fixed fees in our model)[10]. These backward margins paid by each of the three manufacturers to retailer 2 are of the same order of magnitude but the wholesale variable profits made with retailer 2 by these manufacturers vary from 6 to 38 millions euros. Backward margins

[10] As we are using proprietary data, we are not allowed to display manufacturers and retailers names and also cannot develop too much interpretations relating profits to the shape of demand and to other characteristics of retailers and manufacturers that would allow identify them.

that manufacturer 3 has to pay to retailer 2 is larger than the wholesale profit that this manufacturer obtains by retailing his products to retailer 2 (remark that there is no inconsistencies here as it simply means that the manufacturer 3 would be even worse off if not selling to retailer 2 who has large market share and could otherwise attract more consumers substituting away from manufacturer 3 products sold in other retailers). This is the result of the buyer power of retailer 2 forcing the manufacturer to propose better contractual terms to itself rather than to retailers 3, 4, 5, 6, 7. The same appears to be true for the two other manufacturers who have to pay backward margins to retailer 2 but of lower magnitude. Other retailer chains do not obtain backward margins but have to pay fixed fees that represent roughly between 10 and 25 percent of their variable retail profit. On the manufacturer side, we obtain that overall they have negative net total fixed fees mainly because of one retailer chain that gets large backward margins while other retailers have to pay fixed fees. All manufacturers obtain the largest fixed fees from retailer 3 but the largest variable wholesale profits come from retailers 5 and 2.

5 Conclusion

In this paper, we presented the first empirical estimation of a structural model taking into account explicitly the endogenous buyer power of downstream retailers in two part tariff contracts between manufacturers and retailers. We show how to estimate different structural models embedding the strategic relationships of upstream and downstream players, using demand estimates and the industry structure. We consider several alternative models of competition between manufacturers and retailers on a differentiated product market and test between these alternatives. We study in particular several types of non linear pricing relationships with two part tariff contracts allowing retailers to enjoy some endogenous buyer power, and where RPM may be used or not. The method is implemented on the market for bottles of water in France in 2006 and estimates of demand parameters using micro-data allow us to recover price-cost margins at the manufacturer and retailer levels as well as fixed fees of non linear contracts for different models. We test between the different models of vertical contracts to select the one that bests fits the data. Our empirical evidence allows to conclude that manufacturers and retailers use two part tariff contracts without RPM and to identify the buyer power of retailers. Fixed fees of two part tariff contracts are endogenously determined by the upstream horizontal competition between manufacturers and allow to identify and estimate the sharing of profits on this market. The buyer power of retailers is thus affected endogenously by the offers from other manufacturers. It does not come only from the retailers private labels but from their ability to use competing offers of manufacturers as outside options. We obtain estimates of total fixed fees and profits across manufacturers and retailers. From an empirical point of view on food retailing in France, our results also shed some light on the effects of regulatory changes of below cost pricing that was implemented in January 2006. Actually, previous research (Allain and Chambolle, 2011, Bonnet and Dubois, 2010, Biscourp et al. 2013) have shown the anticompetitive effects of the 1996 Galland act that defined resale at loss without taking into account backward margins received by retailers and facilitated resale price maintenance until 2005. This showed the importance of taking into account the widespread use of non linear prices in vertical contracting. Our results post Galland Act, reformed in 2006, confirm that resale price maintenance was not anymore at work. We obtain fixed fees, margins and profits showing that fixed transfers can account for very variable share of total profit with more than half of profit for the most profitable retailer chain (in the sense of the chain having the largest total profit but not as a share of capital that we don't observe) who obtains substantial backward margins (negative fixed fees in our model). Other retailer chains do not obtain backward margins but have to pay fixed fees that represent roughly between 10 and 25 percent of their variable retail profit. On the manufacturer side, we obtain that overall they have negative net total fixed fees mainly because of one retailer chain that gets large backward margins while other retailers have to pay fixed fees.

The method can be used for many sectors where non linear (two part tariff) contracts are used. It can be useful for competition and merger analysis where one needs identifying margins and profits. Our modelling considered "bundling" contracts where manufacturers make take-it-or-leave-it offers to retailers for their multiple products but generalizing to unbundled contracts is straightforward even if more demanding in terms of empirical estimation. Considering unbundling is likely to reinforce the buyer power of retailers, allowed to accept part of the brands of a manufacturer instead of the whole bundle. Endogenizing the bundles of goods offered to retailers as well as the possible foreclosure effects in this industry is an interesting research direction (Rey and Stiglitz, 1995, Rey and Tirole, 2007). The markets for bottles of water in France does not seem to be importantly affected by such strategies but other markets are (Asker, 2005) and further work needs to be done in this direction. Another research direction concerns the questions of exclusivity restrictions in vertical contracting and their role with buyer power as discussed in Marx and Shaffer (2007), Myklos-Thal, Rey, and Vergé (2011), and Rey and Whinston (2013) that provide interesting framework but for which no structural empirical studies have been done yet.

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6 Appendix

6.1 Confidence Interval Tables

Table 9 : Confidence intervals for average yearly Fixed Fees F_{fr}

	Manufacturer f		
Retailer r	1	2	3
1	[-2,061 ; -1,232]	[93 ; 735]	[-944 ; -114]
2	[-19,530 ; -18,240]	[-15,910 ; -14,660]	[-18,220 ; -16,920]
3	[682 ; 1,443]	[973 ; 1,734]	[810 ; 1,571]
4	[2,017 ; 3,117]	[2,129 ; 3,229]	[2,041 ; 3,142]
5	[2,285 ; 4,255]	[379 ; 1,591]	[230 ; 2,201]
6	[855 ; 1,313]	[906 ; 1,363]	[883 ; 1,341]
7	[813 ; 1,119]	[856 ; 1,163]	[841 ; 1,147]

Notes : Numbers in brackets are Monte Carlo simulated 95% confidence intervals using variance of demand coefficients (using 200 draws).

Table 10 : Confidence intervals for average yearly wholesale variable profits π^{w}_{fr}

	Manufacturer f		
Retailer r	1	2	3
1	[5,771.5 ; 8,404.4]	[19,514.0 ; 28,308.9]	[3,417.8 ; 4,625.3]
2	[11,788.7 ; 17,569.8]	[33,125.6 ; 44,823.9]	[5,458.1 ; 7,321.3]
3	[5,060.9 ; 8,238.3]	[15,913.5 ; 23,708.1]	[2,783.9 ; 4,019.7]
4	[7,149.5 ; 10,823.6]	[22,068.0 ; 32,334.4]	[3,728.4 ; 5,331.0]
5	[11,418.7 ; 16,677.2]	[34,287.0 ; 49,065.6]	[6,583.2 ; 8,729.1]
6	[3,572.4 ; 5,492.8]	[10,790.9 ; 16,557.7]	[1,586.3 ; 2,447.5]
7	[3,457.7 ; 4,653.0]	[11,932.3 ; 18,679.3]	[1,589.4 ; 1,965.8]

Notes : Numbers in brackets Monte Carlo simulated 95% confidence intervals using variance estimates of demand coefficients (200 draws).

Table 11 : Confidence intervals for average yearly retail variable profits π^{r}_{fr}

	Manufacturer f		
Retailer r	1	2	3
1	[6,380.2 ; 9,782.6]	[12,415.2 ; 18,874.1]	[2,842.2 ; 3,867.9]
2	[10,004.8 ; 16,303.3]	[19,404.9 ; 28,479.5]	[4,208.7 ; 5,923.9]
3	[5,117.4 ; 8,442.2]	[9,681.4 ; 14,978.4]	[2,191.3 ; 3,216.5]
4	[7,628.6 ; 12,230.4]	[14,255.8 ; 22,146.8]	[3,051.6 ; 4,568.2]
5	[13,771.4 ; 21,275.0]	[24,471.9 ; 37,933.6]	[5,709.5 ; 7,985.2]
6	[3,177.0 ; 5,056.2]	[5,815.4 ; 9,309.9]	[1,178.1 ; 1,890.7]
7	[2,905.0 ; 3,984.8]	[5,864.4 ; 10,362.1]	[1,315.7 ; 1,602.4]

Notes : Numbers in brackets Monte Carlo simulated 95% confidence intervals using variance estimates of demand coefficients (200 draws)

6.2 First stage estimation

Table 8 : First stage OLS regression of prices

Dependent variable : p_{jt}	Coefficient	Std. Error
Wage index	0.0037***	(0.0008)
Plastic price	-0.0003	(0.0008)
Diesel oil price	0.0007*	(0.0004)
$\lambda_{b(j)}$, $\lambda_{r(j)}$ are not shown		
N	728	
R^2	0.98	

Notes : *, **, *** mean significance at 1%, 5%, 10% respectively.

6.3 Detailed resolution of system of equations

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

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

where A_f and B_f are some given matrices.

Solving this system amounts to solve the following minimization problem

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

leads to the first order conditions

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

that allow to find the following expression for its solution

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

6.4 Non Nested Tests

Denoting Γ_{jt}^h and γ_{jt}^h the wholesale and retail margins of product j in period t under the supply model h, and let's consider two models h and h' with

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

and

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

Non-nested tests (Vuong, 1989, and Rivers and Vuong, 2002) are then applied to infer which model h is statistically the best. The test of Vuong (1989) applies in the context of maximum likelihood. Rivers and Vuong (2002) generalized this kind of test to a broad class of estimation methods including nonlinear least squares. These test involve testing one model against each other without requiring that either competing model be correctly specified under the null hypothesis. Other approaches such as Cox's tests (see, among others, Smith, 1992) require such an assumption.

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 $Q_n^h(\lambda_h, \omega_j^h)$ evaluated for model h (resp. h') at the pseudo-true values denoted $\overline{\lambda}_h$, $\overline{\omega}_j^h$ (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. The test statistic T_n is 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. As 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[11].

[11] 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.