The effect of private labels in retailer competition

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Abstract

In this paper, we assess the effect of private labels on retailer competition by estimating a structural model of demand and supply. Private labels can play two roles in this competition. First, they may serve as a differentiation tool for the retailers in order to soften price competition. Second, they may help the retailers to obtain better conditions from their manufacturers. Differentiation is taken into account by estimating a discrete-continuous choice model for the demand side , with the retailer's policy towards private labels entered as one of the characteristics. For the supply side, we propose simultaneous location-and-price game between retailers and use its first-order conditions together with the demand parameters to derive estimates for marginal costs and for the elasticity of marginal costs to increases in the retailers' offer of private labels.

1 Introduction

Private labels (PLs) have been growing in importance within the food retailing industry during the last years. Several explanations can be found to justify why a retailer may find profitable to introduce a PL in its offer. The most common justification in the IO literature lies in the vertical relationship between manufacturers of National Brands (NBs) and retailers. In this context, PLs are used by the retailer as a mean to either reduce the double marginalization problem or to gain some bargaining power in front of manufacturers. The marketing literature, on the other hand, has stressed the role of PLs as a tool for either better price discriminate among consumers or for generating consumer loyalty to the store. All these explanations are in line with statements made by industry managers. Bergès-Sennou et al [2004] cite a survey by LSA/Fournier[1] according to which the main reasons retailers develop PLs are: to increase customer loyalty (16%), to improve their positioning (18%), to improve margins (25%) and to lower prices (33%). More direct conversations with managers reveal that, at least for some retailers, PLs were developed as an instrument to fight back the entry of Hard Discounters (HDs) in the industry[2].

The purpose of this paper is to integrate all these considerations in a single framework in order to better describe how PLs affect the competition between retailers. From their point of view, private labels play a role both in the demand and in the supply sides. Hence, a complete evaluation of the impact of PLs in retailer competition needs to take into account both of them. We will follow the literature on structural models of competition (see, for example, Berry, Levishon and Pakes [1995], Nevo [2001], Ivaldi and Verboven [2001] or Bonnet, Dubois and Simioni [2004]) to estimate the parameters of the demand that, together with an assumed equilibrium condition for the game played by the retailers, will yield estimates for the margins and marginal costs of each retailer. In order to account for the possible effects of private labels on the supply side, we will endogeneize the location of retailers in the characteristic space defined by the policy towards PLs. The framework is similar to Draganska and Jain [2005], who assume simultaneous price and product line competition for the supply side.

The role of private labels on demand side is two-fold. On one hand, PLs serve as a differentiation tool for retailers. In the characteristics approach to product differentiation, each consumer has an ideal mix of private labels and national brands in the assortment of the retailer. These ideal points are dispersed along the characteristics space, in which retailers themselves locate by choosing their policy towards these kinds of products. Consumers with stronger preferences for PLs will naturally choose to visit those retailers offering a larger assortment of them. Thus the differentiation aspect of PLs comes into play in retailers' competition for the customers. Once the customers are in the store, PLs play a second role of price discrimination in each of the product lines offered by the retailer. In this case, the private label is an option that the retailer can use to better screen the willingness to pay of the different consumers in its customer base. *See Putsis 1997 and Stole 2005.* These two

[1] LSA/Fournier "Les marques de distributeurs", Libre Service Actualités, 1472 (January 1996):10-15.

[2] This is the case, for example, of Leclerc in France who changed its policy towards PLs in 1998 after the successful entry of Aldi and Lidl to the french market.

mechanisms also explain why PLs emerged as a response to the entry of hard discounters: consumers with the lowest willingness to pay for NBs were attracted by stores offering cheap PL products, reducing the customer base of the incumbent retailers. Retailers had then the choice between a smaller customer base but with a higher average willingness to pay - given that entrants provided the screening device - or keeping the customer base and pursuing themselves the screening through the introduction of private labels.

To determine whether the development of private labels is an important tool of differentiation among retailers, we estimate a discrete-continuous choice model for the demand side (following Hanemann [1984] and Smith [2004]): consumers choose which retailer they patronize and how much they spend depending on the retailers' characteristics. A survey published in a study ordered by the Office of Fair Trading about competition in the retailing industry[3] identified the principal factors affecting the choice of a grocery store. Low price was classified in the third place, just behind the product range and selection and immediately after the quality of the service. The main factor driving the choice was convenience. This points to a moderate importance of price competition and shows that retailers are differentiated according to location and product selection. The strategy of the retailers towards PL products affects this last factor of differentiation, thus raising the possibility that some features of this strategy contribute to soften even more the competition in prices. Hence, we estimate the determinants for patronizing a retailer, and the consumer's expenditure at it, as a function of prices, retailer's and consumer's characteristics. The effect of PLs as a potential differentiation device is captured through variables reflecting each retailer's general PLs policy - the percentage of its offer devoted to PL varieties, the n^o of product lines with a PL presence... These variables are included in the store characteristics. In this way, we can get an indication of the effect they have on the consumers' valuation of the bundles that can be purchased at each retailer.

We follow Smith [2004] closely in the functional form chosen for the indirect utility as well as in the way to account for heterogeneity in consumer preferences. However, there is a main difference with respect to Smith's approach. In his article, retailer prices are treated as an unobservable in the estimation of the choice model. Assuming a multi-store Nash pricing equilibrium on the supply side and using data on marginal costs, price parameters

[3] Office of Fair Trading, "Competition in Retailing", Research Paper n^o 13, September 1993. See section 2.2.3 on Consumer relationhips.

are estimated later using the expression for the profit margins - which is in terms of these price parameters. Our situation is the opposite to Smith's, as it is usual in the literature. Given the fact that our database records the prices of all the products purchased in any retailer, we can explicitly compute a price index for each store. This computation has the advantage of allowing a direct estimation of the conditional demand elasticity, which is not the case in Smith. Since prices affect retailer choice and expenditure through two different parameters and they are treated as unobservables, Smith is not able to separately identify them. Instead, he assumes a value for their ratio so that it implies a plausible conditional (on retailer choice) demand elasticity and estimates only one of the price parameters.

With the estimates of the discrete-continuous choice model at hand, we can compute the demand observed by each retailer. Assuming a Nash equilibrium in prices in the game played by the firms owning the different retailers, we can express the vector of retailers' margins as a function of demand parameters. From these margins, we can recover each retailer's marginal cost, which reflect a combination of all products' wholesale prices plus marginal costs of distribution.

Nevertheless, and also given the particular characteristics of the French retailing sector, it is interesting to consider competition along more than one dimension. French regulation forbids the resale at a loss for retailers[4]: the retailer cannot set the price of the good below the price appearing on the bill from the supplier. All rebates and reductions, i.e. listing fees, payable at the end of the year but anticipated by the retailers cannot be deduced from the price appearing in the bill. Moreover, as general terms of sale have to be non-discriminatory according to commercial law, the effect of the ban on resale at a loss is equivalent to allowing floor prices: manufacturers can collude to increase wholesale prices and pay the retailers through negotiated listing fees (Allain and Chambolle [2005]). In this case, price competition between retailers is significantly restricted and they have to find other dimensions in which to compete. Competition along the location in the characteristics space, which in this case is a form of competition in product lines, arises as a reasonable option. Indeed, one can think that after a merger the retailers involved may find profitable to reorganize their offers of PLs and NBs in order to better discriminate among consumers and reduce competition between

[4]Resale at a loss was introduced with the Galland Law in 1996. Several studies, including one carried over by the French Competition Authorities, recognized an inflationary effect of the law. This has lead to a revision of the law in 2005.

them (Gandhi et al [**?**]).

Retailers' decisions on their location in the PLs policy space can also be motivated by the possible different effect of national brands or private labels on the wholesale prices offered by the manufacturers. Literature on the vertical relationship between manufacturers and retailers has pointed to two different ways by which PLs can help to obtain lower wholesale prices on branded products: when linear pricing is used to set wholesale prices, the introduction of a PL by the retailer reduces the double-marginalization problem (Mills [1995] and Bontems et al [1999]); if non-linear pricing is used instead, Rey and Vergé [2004] show how they offer the possibility to refuse the contracts proposed by the manufacturers, increasing the pay-off of non-contracting and thus the rent to retailers.

We thus propose a simultaneous location-and-price game between retailers and assume their constant marginal costs to be a function of the mix of national brands and private labels in their assortment. This framework allows to simulate retailers' response to changes in demand conditions and compute their effect on their general level of prices and product mix, taking into account the possible effect on costs.

The paper is organized as follows. Next section presents a brief review of the literature on private labels. It follows the formal description of the model for the choice of a retailer and the likelihood function. The different equilibrium assumptions are discussed in section 4. Section 5 presents an introduction to the dataset and a summary of the kind of data we work with. The computation of the price index is also discussed in a subsection. Finally, the last two sections contain notes on the estimation and the simulation of demand shocks which are still in progress.

2 Review of the literature

Literature on the effects of PLs on competition has analyzed mainly the relationship between retailers, manufacturers and their branded products (or NBs). According to this stream of literature, retailers would introduce PLs in order to increase their bargaining power vis à vis manufacturers.

The usual framework is a vertical structure with one manufacturer and one retailer, both in a monopoly position. If only linear prices are considered (Mills [1995], Bontems et al [1999]), then this structure suffers from the double marginalization problem. In that case, by introducing a PL, the retailer creates competition in the downstream market which reduces manufacturer's market power. Consequently, wholesale price decreases and so does the double marginalization problem. Consumer's surplus rises unless the cost of producing the PL is too high. When non-linear tariffs are allowed (Caprice [2000], Rey and Vergé [2004]), the double marginalization problem disappears, since wholesale price is set at marginal cost. In this case, the mechanism through which the retailer gains bargaining power is the reservation profit. Assuming the manufacturer makes a take-it or leave-it offer, the opportunity to sell a PL creates some profit for the retailer even if he does not sell the national brand (NB). Thus, for the retailer accepting the offer, the manufacturer must leave some rents to him that match this reservation profit.

There has been also much interest in determining what is the effect of a PL introduction on the prices of the NBs. Theoretical works tend to favour the prediction of a decline in NB's prices whereas empirical works have shown more heterogeneous results. Gabrielsen et al [2004] find a positive effect (when significant) of a PL introduction in the prices of NBs. This effect is larger for high and moderately successful PL introductions and larger on leading brands. Also Ward, Shimshack, Perloff and Harris [2002], regarding the effect of PL penetration on individual NB prices per category, find that NB prices tend to rise with PL share and this increase varies within NBs. In some categories the price increase is much higher in the leading brand and in others it is much higher in the second or third brands. More recently, Bontemps et al [2005], using a similar methodology, show that the positive impact on NB prices is higher for increases in the market share of PL products *strictu sensu*. For other kind of PL products - those exclusively sold by hard discounters or those that are low price products - the effect on NB prices is negative in half of the categories with significant effects and, in any case, their effect is lower than that of strictly PL products.

The other reasons stated for introducing a PL - to increase customer loyalty and improve positioning - have more to do with the horizontal relationships between retailers and have been the subject of less attention in the literature. On the theoretical side, Corstjens and Lal [2000] take this approach and try to "show when and why the store brand can become a source of store loyalty for the retailer". They show that even when there is no cost advantage with respect to NBs, retailers may find profitable to introduce a PL with a relatively high perceived quality since it is capable of creating store loyalty. Conversely, low cost low price

PLs only increase price competition between retailers. Basically, a PL works as a brand that is under exclusive distribution in a single retailer. If there exists a certain level of brand-loyalty for this PL, this loyalty is directly translated into retailer-loyalty. This is then a source of switching costs for the consumers, leading to the usual pricing situations and trade-offs described by Klemperer [1995] of firms facing consumers with switching costs. This intuition would be in line with the empirical findings of a raise in NB prices after the introduction of PL varieties.

Moreover, empirical results by Bonfrer and Chintagunta [2003] support the mechanism explained by Corstjens and Lal. They use a panel of 104 product categories for five competing retailers in one region and construct measures of brand loyalty, store loyalty and store brand purchase. They find that store loyal consumers are more likely to buy PL varieties. Higher store loyalty is associated with lower brand loyalty within a store and also with lower store-invariant measures of brand loyalty. This last correlation suggests that loyal PL consumers tend to be those with less brand loyalty in general.

Corstjens and Lal further suggest that consumer's loyalty to a retailer should be even higher when he/she opts for purchasing PLs in more than one category of products. This argument would call for a positive relationship between the retailer's probability of being selected and the share of PLs in the total expenditure of the consumer at this retailer. However, reasons in favour of finding the opposite relationship have also been suggested in the literature. Sudhir and Talukdar [2004] mention the argument that PLs could attract mainly deal prone consumers and cite the work of Dick et al. [1995] who find that store brand customers are more price sensitive than average consumers. Furthermore, if the PL products offered by one retailer are perfect substitutes for PL products offered by another retailer, then the mechanism proposed by Corstjens and Lal for generating retailer-loyalty does not work and the above mentioned relationship would not exist. Evidence of at least some degree of substitution is found by Ailawadi and Harlam [2004], who find that retailers' margin on PLs decreases as the percentage of competing retailers carrying a PL in the category increases.

3 The choice of a retailer

Retailer's demand is modeled as a combination of discrete and continuous choices. In every purchasing act, the individual chooses first the retailer and then the quantity purchased at this particular retailer. These decisions depend on consumer and retailer characteristics. In particular, since the purchasing act of an individual is motivated by the need of several different products, the choice of the retailer is going to depend on the prices he charges to the different products he sells. We can simplify this by considering that every retailer offers a particular bundle of goods with a certain price. Then, the choice of a retailer is equivalent to purchase one of the offered bundles. We analyze the consumer's selection of the first-choice retailer, that is to say, the retailer in which an individual makes the larger part of his purchases.

More formally, and following Hanemann [1984], the individual consumer i has a direct utility function at time t,u_{it}, defined over the quantities $x_1, ..., x_J$ of the bundles proposed by J different retailers, and on the numeraire z (which will represent the amount left for top-ups and other purchases in second choice retailers or other minor retailers included in the database). The consumer's utility also depends on L characteristics of the retailer where the purchase is made, which will be denoted by $b_1, ..., b_L$. Finally, the utility can also be influenced by M characteristics of the individual, $s_1, ..., s_M$. The vector ϵ is going to collect all the characteristics of the retailer and the individual that are unobservable for the econometrician.

At every period t, the individual consumer maximizes this direct utility function $u(x, z, c, s, \epsilon)$ subject to J non-negativity constraints (one for each x_{ij}) and the budget constraint:

$$\sum_{j=1}^{J} p_j x_{ij} + z_i = y_i$$

where y_i is the consumer's total expenditure in food. Discreteness in the consumer's decision is given by the fact that some of the non-negativity constraints hold with equality. Given that we consider the selection of the first-choice retailer among the J possible alternatives, these alternatives are mutually exclusive. Hence, $J - 1$ of the non-negative constraints will be binding. Given this, the problem reduces to choose the pair (x_{ij}, z_i), with the other x_i's set to 0. This maximization yields a demand function $\overline{x}_{ijt}(p_{jt}, y_{it}, b_{jt}, s_{it}, \epsilon_{ijt})$ and an indirect utility function of the form $\overline{v}_{ijt}(p_{jt}, y_{it}, b_{jt}, s_{it}, \epsilon_{ijt})$, both conditional on the purchase of the bundle belonging to the j^{th} retailer. The selection among the different retailers is made from a choice set J_i, defined as all the retailers present less than 16 Km away[5] from consumer i,

[5]This corresponds to a travel time of less than 20 minutes, assuming an average speed of 50 km/h.

and it will be given by the following condition:

$$\overline{v}_{ijt}(p_{jt}, y_{it}, b_{jt}, s_{it}, \epsilon_{ijt}) \geq \overline{v}_{ikt}(p_{jt}, y_{it}, b_{jt}, s_{it}, \epsilon_{ijt}) \qquad \forall k \in J_i \tag{1}$$

The outcome of this selection process is random from the point of view of the econometrician because of the unobservability of ϵ. Therefore, the different choices will be observed with a probability induced by the distribution of the elements in ϵ. The next step in the analysis is to specify a functional form for the conditional indirect utility function. We use the same functional form as Smith, which is in turn very close to the one used in Dubin and Mcfadden [1984]. Accordingly, the conditional indirect utility function has the following shape:

$$\overline{v}_{ijt} = \mu \left[\beta_2^{g(i)} y_{it} + \beta_1^{g(i)} \ln p_{jt} + \boldsymbol{s}'_{it}\alpha^{g(i)} + \psi_{1jt}^{g(i)}\right] \exp\left[(\phi_{2R}^{g(i)} - \beta_2^{g(i)} \ln p_{jt})\zeta_{it}\right] + \psi_{2ijt}^{g(i)} + \epsilon_{ijt} \tag{2}$$

where g identifies types of consumers with identical preferences, μ is a scaling term, $\boldsymbol{s}_{it}$ is a vector of individual characteristics and $\psi_{1jt}^{g(i)}$ and $\psi_{2ijt}^{g(i)}$ are retailer quality indexes defined as:

$$\psi_{1jt}^{g(i)} = \phi_{1R}^{g(i)} + \mathbf{b}'_{1jt}\delta^{g(i)} \tag{3}$$

$$\psi_{2ijt}^{g(i)} = \mathbf{b}'_{2ijt}\theta^{g(i)} \tag{4}$$

The reason for having two different indices is that some of the retailer characteristics included in $\mathbf{b}'_{2jt}$ - and which may be faced differently by each individual - are not going to influence the demanded quantity of the bundle. Similarly, $\phi_{1R}^{g(i)}$ and $\phi_{2R}^{g(i)}$ are retailer fixed effects with $\phi_{2R}^{g(i)}$ capturing all those unobserved characteristics of the retailer that only affect the consumer's choice but not the conditional expenditure. Heterogeneity in consumer tastes is introduced by estimating different sets of parameters $\Theta^g = (\beta_1^g, \beta_2^g, \alpha^g, \phi_{1R}^g, \phi_{2R}^g, \delta^g, \theta^g)$ for every consumer type g. The assignment of consumers to different types is done according to individual characteristics (income and location).

Individual's indirect utility is also affected by unobservable personal characteristics, such as consumption habits, captured through the univariate random variable ζ_{it} and which is assumed to follow a log-normal distribution $LN(0, \lambda^g)$[6]. The other source of randomness are unobserved disturbances to individual's valuation of retailer j at time t, denoted by ϵ_{ijt}, and

[6] Hence, $E[\zeta^g] = e^{\lambda^g/2}$ and $Var[\zeta^g] = e^{\lambda^g}\left(e^{\lambda^g} - 1\right)$

assumed to be an i.i.d Type-1 Extreme Value distribution function in standard form with unit scale parameter. In addition, these two random variables are assumed to be independent.

The application of the Roy's identity results in the following consumer i's conditional demand at time t for a bundle from retailer j:

$$\overline{x}_{ijt} = \frac{1}{p_{jt}} \left[\left(\beta_2^{g(i)} y_{it} + \beta_1^{g(i)} \ln p_{jt} + \boldsymbol{s}'_{it} \alpha^{g(i)} + \psi_{1jt}^{g(i)} \right) \zeta_{it} - \frac{\beta_1^{g(i)}}{\beta_2^{g(i)}} \right] \tag{5}$$

and multiplying it by its price, we obtain the conditional expenditure:

$$\overline{e}_{ijt} = \left(\beta_2^{g(i)} y_{it} + \beta_1^{g(i)} \ln p_{jt} + \boldsymbol{s}'_{it} \alpha^{g(i)} + \psi_{1jt}^{g(i)} \right) \zeta_{it} - \frac{\beta_1^{g(i)}}{\beta_2^{g(i)}} \tag{6}$$

From the above expressions, it can be seen that characteristics included in $\psi_{2ijt}^{g(i)}$ do not affect the conditional demand and, therefore, the expenditure. These are likely to be retailer characteristics such as the distance from the consumer's home or the number of cashiers. With respect to the fixed effects, they capture retailers' characteristics that are constant through time. It is reasonable to think that retailers' reputation is one of these characteristics.

3.1 Derivation of the Maximum Likelihood

Given the functional form chosen for the indirect utility and the distribution of ϵ_{ijt}, the probability of retailer j to be selected by individual i - conditional on the unobserved individual i's characteristics - follows a multinomial logit:

$$s_{ijt}\left(\zeta_{it}\right) = \frac{\exp\left\{ \mu \left[\beta_2^{g(i)} y_{it} + \beta_1^{g(i)} \ln p_{jt} + \boldsymbol{s}'_{it} \alpha^{g(i)} + \psi_{1jt}^{g(i)} \right] \exp\left[(\phi_{2R}^{g(i)} - \beta_2^{g(i)} \ln p_{jt}) \zeta_{it} \right] + \psi_{2ijt}^{g(i)} \right\}}{\sum\limits_{k \in J_i} \exp\left\{ \mu \left[\beta_2^{g(i)} y_{it} + \beta_1^{g(i)} \ln p_{kt} + \boldsymbol{s}'_{it} \alpha^{g(i)} + \psi_{1kt}^{g(i)} \right] \exp\left[(\phi_{2R}^{g(i)} - \beta_2^{g(i)} \ln p_{kt}) \zeta_{it} \right] + \psi_{2ikt}^{g(i)} \right\}} \tag{7}$$

The unconditional probability of individual i selecting retailer j can be found by integrating out over the distribution of the unobserved individual characteristics:

$$r_{ijt} = \int_{\zeta} s_{ijt}\left(\zeta_{it}\right) f_{\zeta}\left(\zeta_{it}\right) d\zeta \tag{8}$$

where $f_{\zeta}\left(\zeta_{it}\right)$ is the density of ζ and is assumed to be identically distributed for all consumers within a type. This unobserved individual characteristic also induces a density of the conditional expenditure, which can be found by a change of variable technique:

$$f_{\overline{e}_{ijt}}\left(\overline{e}_{ijt} \mid j\right)=\frac{1}{\left[\overline{e}_{ijt}+\left(\beta_1^{g(i)}/\beta_2^{g(i)}\right)\right]\sqrt{2\pi\lambda}}\exp\left\{-\frac{\left[\ln\left(\frac{\overline{e}_{ijt}+\left(\beta_1^{g(i)}/\beta_2^{g(i)}\right)}{\beta_2^{g(i)}y_{it}+\beta_1^{g(i)}\ln p_{jt}+\boldsymbol{s}_{it}'\alpha^{g(i)}+\psi_{1jt}^{g(i)}}\right)\right]^2}{2\lambda^{g(i)}}\right\} \tag{9}$$

Therefore, the joint probability of observing consumer i spending an amount of $\overline{e}$ in retailer j at time t is given by the product of equations (8) and (9) and the likelihood of the sample is given by the following expression:

$$\ln L=\sum_{i,j,t} d_{ijt}\left\{\ln r_{ijt}+\ln\left[f_{\overline{e}_{ijt}}\left(\overline{e}_{ijt} \mid j\right)\right]\right\} \tag{10}$$

where d_{ijt} is a dummy variable indicating whether consumer i chose retailer j at time t or not.

4 The Retailers' Game

4.1 Price Competition

We first assume that retailers compete in prices, taking as given the vector of store characteristics determined in a previous stage. Thus, the observed prices are those arising from the Nash equilibrium of this game. A single firm can own several retailers and form a group (i.e. at the time of writing this paper, the Carrefour group owns in France the Carrefour hypermarkets, the Champion supermarkets, the hard-discount Ed and other proximity retailers such as 8 à Huit). Hence, we assume that prices are chosen by each group of retailers in order to maximize the joint profits of their members.

Denoting by J_h the set of retailers owned by group h, $(h=1,..,H)$, and by M^g the number of existing consumers of type g, at time t the group profits arising from this type of consumers are given by the following expression[7]:

$$\Pi_h^g=M^g\sum_{j\in J_h}\left(p_j-c_j\right)\cdot s_j^g\cdot x_j^g \tag{11}$$

[7]Substript t is omitted in this section to ease notation.

Each retail group will maximize the joint expected profits, $\sum_g \int_{\zeta_i} \Pi_h^g dF(\zeta_i)$, with respect to the price level of each retailer in the group. Therefore, the derivative of profits arising from consumers of type g with respect to price for a particular retailer $j \in J_h$ and retailer groups $h = 1, ..., H$:

$$\frac{\partial \Pi_h^g}{\partial p_j} \equiv M^g \cdot s_j^g \cdot x_j^g + M^g (p_j - c_j) \cdot s_j^g \cdot \frac{\partial x_j^g}{\partial p_j} + M^g \sum_{k \in J_h} (p_k - c_k) \cdot x_k^g \cdot \frac{\partial s_k^g}{\partial p_j} \tag{12}$$

because $\frac{\partial x_k^g}{\partial p_j} = 0 \quad \forall k \neq j$. The first term of the summation measures the extra profits coming from the price increase over the quantity that was sold before the rise. The second term reflects the change in the quantity sold due to the price increase. This quantity can change through a decrease in the retailer's probability of being selected by the consumer but also through a decrease of the expenditure made by the consumers. The final term captures the effect of a change in retailer j's prices on the profits of the other retailers of the group.

Considering all the possible types of consumers, the first order condition for retail group h with respect to price p_j can be expressed as:

$$\frac{\partial \Pi_h}{\partial p_j} \equiv \sum_g \left\{ \int_{\zeta_i} \frac{\partial \Pi_h^g}{\partial p_j} dF(\zeta_i) \right\} = 0 \tag{13}$$

Every retailer in group h sets its price level to maximize the sum of the expected profits derived from each segment of consumers. Thus, the observed price levels must satisfy the system of J equations formed by the first-order conditions (13). The only unknowns left are the marginal costs c_j of each retailer, which can be obtained by solving this system of equations. To see that, the first-order conditions can be expressed in matrix notation.

Define I_h as the ownership diagonal matrix of retail group h, which is of size $J \times J$ and whose elements $I_h(j, j)$ are equal to 1 if retailer j belongs to group h and 0 otherwise. Denote by i_h the vector containing the diagonal elements of I_h. Let S_p and X_p be two $J \times J$ matrices containing the sum across consumer types of expected responses of quantity to a change in prices coming through, respectively, a change in the market share and a change in the conditional demand, i.e.

$$S_p \equiv \begin{pmatrix} \sum_g M^g \cdot \int \left(x_1^g \cdot \frac{\partial s_1^g}{\partial p_1} \right) dF(\zeta_i) & \cdots & \sum_g M^g \cdot \int \left(x_J^g \cdot \frac{\partial s_J^g}{\partial p_1} \right) dF(\zeta_i) \\ \vdots & & \vdots \\ \sum_g M^g \cdot \int \left(x_1^g \cdot \frac{\partial s_1^g}{\partial p_J} \right) dF(\zeta_i) & \cdots & \sum_g M^g \cdot \int \left(x_J^g \cdot \frac{\partial s_J^g}{\partial p_J} \right) dF(\zeta_i) \end{pmatrix} \tag{14}$$

$$X_p \equiv \begin{pmatrix} \sum_g M^g \cdot \int \left(s_1^g \cdot \frac{\partial x_1^g}{\partial p_{1j}} \right) dF(\zeta_i) & & 0 \\ & \ddots & \\ 0 & & \sum_g M^g \cdot \int \left(s_J^g \cdot \frac{\partial x_J^g}{\partial p_J} \right) dF(\zeta_i) \end{pmatrix} \tag{15}$$

Note that the off-diagonal elements of X_p are zero due to our formulation of the conditional demand, which makes it dependent only on the own-price of the retailer. Finally, define Q as a diagonal matrix whose element $Q(j,j)$ contains the expected total quantity sold by each retailer j, i.e. $\sum_g M^g \cdot \int \left(s_j^g \cdot x_j^g \right) dF(\zeta_i)$. Then, the margins $\gamma \equiv p - c$ of retailers of group h are given by the following expression:

$$Qi_h + (I_h X_p + I_h S_p I_h)\, \gamma = 0 \quad h = 1, ..., H \tag{16}$$

The solution to this system of equations can be found by minimizing the sum of squares of condition (16). This yields a solution for γ of the form:

$$\gamma \equiv p - c = - \left[\sum_h \left[I_h (X_p + S_p I_h) \right]' \left[I_h (X_p + S_p I_h) \right] \right]^{-1} \sum_h \left[I_h (X_p + S_p I_h) \right]' Qi_h \tag{17}$$

When solving the system of J equations, we obtain an estimate for the marginal cost of each retailer. This estimate is of course dependent on the assumed game that is played by the retailers. Were the retailers engaged in another form of game, such as tacit collusion, the real marginal costs would differ from those estimated here. Many empirical applications trying to uncover the form of competition prevailing in an industry use this approach to compute different marginal costs, under several forms of competition, and compare them to external estimates (i.e. obtained from firms' accounts). In our paper, however, we will assume that competition takes the form of the game exposed above and use the estimated marginal costs to simulate the effect of demand shocks on the retailers' policy about prices and PLs.

4.2 Simultaneous Location-and-Price Competition

Suppose now that retailers compete in their location in the characteristics space and in prices, choosing both variables simultaneously. More specifically, retailers can vary their offer in PL and NB so as to attract more consumers to the store and, possibly, affect the expenditure they make at it. This kind of game implies a second set of first-order conditions that adds to the set defined in (13), which allow us to recover more information on the parameters determining retailers' marginal costs.

Literature on the vertical relationship between manufacturers and retailers has signaled the importance of PLs in the outcome of this relationship. When linear pricing is used to set wholesale prices, the introduction of a PL by the retailer reduces the double-marginalization problem and allows the retailer to purchase NBs at a lower wholesale price. If non-linear pricing is used instead, PLs can be used by the retailers to increase their market power within the vertical structure. Rey and Vergé [2004] show how they offer the possibility to refuse the contracts proposed by the manufacturers, since retailers can rely on other manufacturers and on their PLs to conform their offer. Moreover, the wider the coverage of PL brands the easier to refuse contracts that bundle several brands of the manufacturer. Since PLs increase the payoff of non-contracting, the manufacturer is obliged to leave a positive rent to the retailer. This rent depends inversely on the retailer's profit on the other brands and can be affected by the manufacturer through the wholesale price offered to the retailer.

In order to test whether PL brands have a different impact than NBs on retailers' marginal costs, we consider that their marginal cost function depends on the ratio in which each type of brands is present in their assortment. Denote this ratio by $\rho_{j\equiv}\frac{PL}{NB}_j$. Therefore, in the simultaneous location-and-price game, retailers forming the group h solve the following problem:

$$\underset{\{p_j\}_{J_h},\{\overline{PL}_j\}_{J_h},\{\overline{NB}_j\}_{J_h}}{Max} \qquad \sum_g \Pi_h^g \equiv$$

$$\equiv \sum_g M^g \left\{ \sum_{j\in J_h} \left[p_j - c_j\left(\rho_j\right)\right] \cdot s_j^g\left(\boldsymbol{p},\boldsymbol{\rho}\right) \cdot x_j^g\left(p_j,\rho_j\right) \right\} \quad (18)$$

Each retailer then choose the level of its ρ_j according to its effect on market share, conditional demand and marginal cost level. We do not impose any functional form for the relationship between this ratio and the level of marginal costs. Instead, we acknowledge that this ratio can affect marginal costs in two ways: a) it may reduce the marginal cost of the bundle of products by substituting branded product varieties by PLs that may be purchased at lower wholesale prices; b) it may reduce the wholesale price for other NBs by increasing the rent that manufacturers are obliged to leave to the retailer. Note, as well, that the level of marginal costs may depend on factors that are known for the retailers but unobserved by the econometrician - i.e. the retailer's ability to negotiate contracts or any bargaining power vis a vis manufacturers and orthogonal to ρ_j. This would create an endogeneity problem if we chose to assess the abovementioned relationship by an OLS regression using the estimates for marginal costs obtained in (17).

Assume there is a unique maximum which is an interior solution (this is confirmed by the data). First-order conditions with respect to price are given by equation (13). The maximization with respect to ρ_j yields the following additional conditions:

$$\frac{\partial \Pi_h}{\partial \rho_j} \equiv \sum_g \left\{ \int_{\zeta_i} \frac{\partial \Pi_h^g}{\partial \rho_j} dF(\zeta_i) \right\} = 0 \tag{19}$$

where the derivative of retail group h's profits arising from consumers of type g with respect to the ratio is given by the following expression:

$$\begin{aligned} \frac{\partial \Pi_h^g}{\partial \rho_j} \equiv -M^g \cdot s_j^g \cdot x_j^g \cdot \frac{\partial c_j}{\partial \rho_j} + M^g (p_j - c_j) \cdot s_j^g \cdot \frac{\partial x_j^g}{\partial \rho_j} + \\ + M^g \sum_{k \in J_h} (p_k - c_k) \cdot x_k^g \cdot \frac{\partial s_k^g}{\partial \rho_j} \qquad \forall j \in J_h, h = 1, ..., H \end{aligned} \tag{20}$$

The derivative of marginal cost with respect to ρ_j and the margin, for each retailer, are the unknowns of these equations. As in the previous case, this system of equations can be written in matrix form. Let Γ_{PL} be the vector of derivatives of retailers' marginal cost with respect to ρ_j. Define S_{PL} and X_{PL} in the same spirit of S_p and X_p, with the price derivative substituted by the derivatives with respect to ρ_j. Then, the implied derivative of marginal costs is given by the following expression:

$$\Gamma_{PL} \equiv \frac{\partial c_j}{\partial \rho_j} = (I_h Q)^- \left(I_h X_{PL} + I_h S_{PL} I_h\right) \gamma \quad \forall h, h = 1, ..., H \tag{21}$$

in which $^-$ denotes the use of a generalized inverse.

Retailers' margins γ can be recovered from (16) and substituted in (21). The estimated margins are the same as in the previous case. The difference is that together with the first-order condition on ρ_j, they imply a set of estimates for the effect of this ratio in marginal costs. The sign of this effect is determined by the observed sign of $(I_h X_{PL} + I_h S_{PL} I_h)$. Elements in the diagonal of the first matrix contain a weighted sum of the effect of ρ_j on the estimated conditional demand of each consumer, with more weight given to consumers with higher purchase probabilities. The rows of the second matrix contain a weighted sum of its effect on the probability of selecting retailer j, with more weight given to individuals with higher estimated conditional demands.

As before, the estimates of the effect on costs will change with the form of the game played by the retailers. In particular, they will be affected by the assumption of observability of the decisions on product assortment.

5 Data

Data on consumer and product characteristics, as well as consumers' retailer choices are drawn from SECODIP: a database recording the purchasing acts of french households through the technique of home scanning. The database consists of individual purchases made from 1998 to 2000 by more than 9000 households[8] in french distributors of food products. It covers all the metropolitan french *departements* and 476 products belonging to 64 different food categories (water, aperitifs, fresh fruits, cheese ...).

The database is organized as a collection of product files in which a typical record is a purchase of that product in a given retailer at a certain date. In this record one has information about the identifying code of the individual, so that we can trace all the purchases of each individual, his/her socio-demographic characteristics, as well as characteristics of the product (brand, price, format ...), quantity purchased and retailer characteristics (name of

[8] The number of households for 1998 is of 9756, that of 1999 is 11310, while the same figure for 2000 is of 12291. Around 1/4 of the panel is renewed every year, thus leaving us with 3710 households present in the whole period.

the retailer, surface of the store and type of retailer).

Since different individuals can have different purchasing habits, and may therefore visit the stores with a different frequency, observations belonging to the same month are grouped together. The choice of the period length as a month is somewhat arbitrary, but it is long enough to capture different habits. Moreover, it will be useful in the construction of price indexes that will avoid short-term oscillations due to product promotions.

Data on outlet characteristics for every retailer is provided by the *Atlas de la Distribution 2005* (purchased to LSA), which lists all the french outlets involved in food distribution. Besides their location, the Atlas provide us with the name of the retailer chain the outlet is affiliated to, its surface, the number of cash registers, the number of employees, the number of parking slots and the number of petrol distributors available in the outlet's petrol station. We merged this information with the SECODIP data using the name of the retailer, the postal code of the consumer's residence and the surface of the outlet. For each of the retailers, we found its outlet with the postal code the closest to the consumer in terms of the Euclidean distance. If this distance was less than 16 Km, the outlet was included in the consumer's choice set. Only one outlet per retailer was included in this set. The computed distance is added as an additional retailer characteristic.

Using the information contained in all SECODIP records, several additional variables have been constructed regarding individuals' and retailers' characteristics (from all the possible retailers, we select 22 of them representing about a 90% of the total sales recorded in the database).

5.1 Individual-specific variables

Purchasing data are aggregated at the individual level, by month, to construct the following variables:

- Monthly expenditure per retailer: All the purchases of a single individual during a particular month are aggregated to form the monthly expenditure of this individual. Purchases made at the selected retailers are identified and the rest of the purchases are aggregated into purchases in the outside option. The average across individuals[9] in the panel is shown in column (1) of table 1.

[9] The average is computed across the individuals having a positive expenditure in the retailer.

- First and second choice retailers: The retailer in which an individual has made the biggest expenditure in a given month has been designed as his first choice. This definition coincides with the INSEE definition of *grande surface principal.* The same computations have been done for the second retailer choice. The average monthly expenditure across consumers in first and second choice retailers is displayed at the bottom of the first column. For every individual, a similar thing has been done with his/her expenditure in PL products in each retailer. Column (2) shows the average of this expenditure across consumers with a positive purchase, of any kind of product, at the retailer and also at first and second choice retailers. The bottom part of the table shows the percentage of individuals whose first choice retailer in terms of total expenditure coincides with his/her first choice retailer in terms of expenditure in PL products.

- Percent spent in PL products: It is the monthly expenditure in PL products made at a given retailer over the consumer's total expenditure at that retailer. This variable reflects the importance of PL products in individuals' average expenditure per retailer and it is shown in the last column.

- Loyalty to a retailer: This is a dummy variable indicating whether an individual's first choice in a given period coincides with his/her first choice retailer in the previous period.

- Loyalty to a retailer 2: It is the percentage that the monthly expenditure spent on a given retailer represents over the total expenditure of an individual across all retailers during that month.

(in French francs)	Average monthly expenditure (1)	Average monthly expenditure in PLs (2)	(2)/(1)
Aldi	171.24	81.30	47.48%
Atac	345.06	41.80	12.11%
Auchan	540.44	75.84	14.03%
Carrefour	513.37	109.62	21.35%
Casino	268.52	57.88	21.56%
CDM	198.42	105.57	53.20%
Champion	406.63	76.97	18.93%
Continent	496.53	92.27	18.58%
Cora	468.36	73.80	15.76%
Franprix	222.23	72.39	32.58%
Geant Casino	257.05	41.49	16.14%
Hyper Champion	468.54	93.29	19.91%
Hyper U	505.82	92.81	18.35%
Intermarche	483.57	124.26	25.71%
Leader price	272.49	205.94	75.58%
Leclerc	536.29	84.91	15.83%
Lidl	249.48	168.00	67.34%
Mammouth	403.11	33.15	8.22%
Monoprix	290.80	44.06	15.15%
Super Monoprix	576.68	79.41	13.77%
Super U	483.57	85.20	17.62%
Geant	373.06	61.54	16.50%
First choice retailer	768.89	158.80	20.79%
Second choice retailer	246.30	59.16	24.02%
All retailers	1,010.47	–	–
Selected retailers	917.70	–	–
First choice retailer in PLs	–	177.52	–
Second choice retailer in PLs	–	59.86	–
Same retailer for general and PL products			79.11%
Same retailer choice as previous period			67.90%

Table 1: Summary statistics of individual data

The data show that the average expenditure in first-choice retailers is significantly larger than in second-choice ones. This suggests that there is an important degree of one-stop shopping in our sample and that the selection of the first-choice retailer is the most relevant decision for the consumer. On the other hand, the rate of PL expenditure over total expenditure is a bit bigger at second than at first choice retailers. Relatedly, slightly more than a 20% of the individuals in the database have a different primary choice for purchasing PL products than his/her primary choice when no distinction is made on the products bought. These consumers are more prone to buy PL products in specific retailers and not in others.

Retailer's reputation and individual characteristics are likely to play a role in this fact. Finally, almost 70% of the individuals in the sample chose the same retailer in two consecutive periods. Whether this is due to the influence of past decisions is a question that has to be tested.

5.2 Retailer-specific variables

Table 2 shows some statistics when the data is aggregated at the retailer level:

- Total sales per period: Column (A) shows the sample average sales per period for each of the selected retailers. Once properly scaled to reflect the size of the French market, this column should be similar to national aggregated data. The second column shows their market shares with respect to total sales in the database.

- Sales in PL products: Column (B) displays the rate of each retailer sales in PL products over its total sales (PL penetration).

- Sample choice probability: This variable captures the number of individuals for which a given retailer is chosen as the first choice. This is computed over the total number of individuals with positive expenditure in a given period.

- Price index: Column (D) shows a price index computed for every retailer using data on prices and quantities purchased of the products available in the database. We will detail the construction of this index and its possible problems in the following subsection.

- Share of PL varieties in total offer: Column (E) presents the number of PL varieties (references) offered by the retailer over the total number of varieties offered. The whole offer cannot be observed and, instead, both the numerator and the denominator have to be computed using the records from SECODIP. The denominator is computed as the addition of the number of varieties offered for each product in a particular outlet for each period. We aggregate the information coming from outlets with a similar surface within a retailer: every outlet is assigned into a group according to its surface in steps of 50 m^2. We divide France into 7 big different regions and thus the sum is conducted by retailer, region, group and period. The computation of the numerator is analogous to that of the denominator but considering only the references identified as PLs. For hard discounters, this share is defined as hard discount brands over total varieties offered.

- Share of NB varieties in total offer: Similar to the previous variable but taking into account only varieties classified as NB. The total number of varieties offered is not equal to the sum of these two last variables because a variety can be also classified as a First Price brand or a Regional Brand.

- Surface, cash registers, employees, car parking, petrol distributors and number of outlets: Columns (G) to (L) present the averages across retailers of the variables provided by LSA's Atlas.

Retailers	(A) **Average sales per period** (in FF)	(B) **Share of PL sales in total sales**	(C) **Avg sample choice prob**	(D) **Avg price index** (in FF)	(F) **Avg share of PL varieties in total offer**	(G) **Avg surface alim.** (in m^2)	(H) **Avg Cash Re-gist.**	(I) **Avg em-ployees**	(J) **Avg parking**	(K) **Avg petrol distr.**	(L) **outlets in 1998 (1999 onwards)**
Aldi	49,648	47.02%	0.74%	37.43	60.35%	663	1	1	9	0	408
Atac	153,261	12.18%	2.17%	53.18	15.74%	1,474	8	42	159	3	138
Auchan	768,501	14.30%	10.13%	48.39	18.71%	10,110	50	472	1,790	9	91 (118)
Carrefour	821,404	21.49%	10.99%	50.59	22.60%	9,508	46	380	1,856	11	157 (169)
Casino	104,393	21.49%	1.55%	55.90	32.90%	1,177	7	32	112	2	243
CDM	33,908	53.86%	0.43%	37.62	64.70%	497	3	4	49	0	7
Champion	268,452	19.00%	3.91%	52.32	27.34%	1,547	9	43	176	4	440
Continent	307,089	16.88%	4.40%	50.26	25.68%	5,644	27	207	887	8	52
Cora	230,613	16.06%	2.83%	51.32	20.88%	9,097	34	344	1,199	9	57
Franprix	58,623	32.55%	0.99%	50.75	42.91%	909	5	12	54	1	9
Geant*	253,590	16.47%	3.39%	52.18	22.28%	6,920	28	219	1,089	8	111
Hyper Champion	17,968	19.48%	0.28%	54.85	28.24%	2,876	15	81	371	4	36
Hyper U	59,265	18.01%	0.75%	49.63	20.62%	3,892	21	151	602	7	38
Intermarche	1,012,263	25.92%	14.42%	47.09	34.37%	1,720	9	42	205	4	903
Leader price	185,703	75.53%	2.67%	37.62	86.30%	899	7	20	76	0	316
Leclerc	1,249,353	16.00%	17.32%	46.89	26.92%	4,335	22	165	652	8	465
Lidl	253,571	66.58%	3.48%	36.43	79.16%	692	1	1	15	0	868
Mammouth	9,846	13.80%	0.14%	52.17	16.95%	6,025	30	251	939	8	40 (1)
Monoprix	73,547	15.16%	1.25%	60.22	22.25%	862	13	63	16	0	219
Super Monoprix	4,968	14.40%	0.04%	82.14	14.26%	1,921	24	165	75	0	3
Super U	401,680	17.68%	5.45%	49.50	23.23%	1,737	10	56	202	4	355
Outside Option**	900,525	19.35%	13.05%	46.91	26.15%	695	4	13	62	1	1,702

(*) SECODIP data for Geant and Geant Casino is aggregated under the name of the former.

(**) Weighted by the number of outlets of each retailer in the outside option, except for the average price index.

Table 2: Summary statistics for retailer data

5.3 The Price Index

The computation of a price index is motivated by our definition of utility for a bundle of goods. We need to assign this bundle a price that reflects the cost faced by the consumers when considering whether to purchase it. The index we compute is a weighted average of the implied prices of the products included in the database.

Given that for every product we have a sequence of different brands purchased at different prices during the time period, first of all we have to compute a single price for this product. The price of a product k is computed, for every selected retailer j and period t, according to the following expression:

$$\widehat{p}^k_{jt} = \frac{\sum_{i=1}^{N^k_{jt}} p^k_{ijt} q^k_{ijt}}{\sum_{i=1}^{N^k_{jt}} q^k_{ijt}}$$

where p^k_{ijt} is the price of the brand corresponding to the ith observation in the database, and that was purchased at retailer j at period t. Similarly, q^k_{ijt} represents the quantity purchased. When the price of a product k at retailer j cannot be computed for a some period t due to the lack of data, this price is set to its average value across periods. Table 9 in the annex gives an indication of the gravity of this problem for each retailer. It shows that it is not much important, except for two retailers which happen to have a very small number of outlets.

Once all the product prices are computed, we collapse them in a single measure by computing a weighted average of them equal to:

$$\widetilde{p}_{jt} = \sum_k \varpi^k \widehat{p}^k_{jt} \tag{22}$$

The weight for each product in the index is given according to:

$$\varpi^k = \frac{\frac{1}{N^k} \sum\limits_{i,j,t} p^k_{ijt} q^k_{ijt}}{\sum\limits_k \left(\frac{1}{N^k} \sum\limits_{i,j,t} p^k_{ijt} q^k_{ijt} \right)}$$

that is to say, the share of the mean expenditure in product k when taking into account all the observations with respect to the sum of mean expenditures in all the products.

In a first computation, all the 476 products were used to construct the index. The resulting price series, however, presented strong fluctuations for some of the retailers[10]. A careful inspection of the data revealed that these retailers had a small number of observations for products with high variation in prices (crustaceous, oysters, quality wine...). Thus, for data on purchases of these products, it was possible to have one month with a purchase of a cheap variety and next moth a purchase of an expensive variety. In order to avoid this problem and to obtain more stable price indexes, we decided to include two selection criteria for the products. The first one is about the average number of observations per retailer and period (the number of observations present for each retailer and period is computed and the average across retailers and periods is taken). When this number is below a given threshold[11], the product is eliminated from the index. Since this criterion still allows for a small n^o of observations for a single retailer, we introduced a second criterion. It eliminates those products for which one can obtain a mean expenditure with a confidence interval including negative values for some retailer. Besides these two criteria, other products were eliminated for several reasons: 11 products were eliminated because they were not present in all the 36 periods; 1 product was eliminated because it seems to present wrongly coded information; and finally, 10 products that are normally sold in units were also eliminated to keep consistency within the quantity variables defined in the rest of the products. In the end, a total of 240 products were retained to form the index. A sample of the main products is shown in table 8 in the annex. The evolution of this index for some of the selected retailers can be seen in figure 1.

Other price indexes could be computed following Diewert [1976]. In particular, the Fisher price index is exact for a general translog expenditure function $e(u, p)$. Since the translog functional form provides a second order approximation to any general expenditure function, it is considered a good approximation to the true cost of living price index. The computation of the weights can also be done in different ways. Tests will be needed to check the robustness of our results to these different price indexes.

The use of a price index may also be considered problematic since it may suffer from endogeneity. By construction, the index takes only into account the prices of those varieties of products finally purchased by the consumer. However, since we are using averages over

[10] Specially for the supermarkets Aldi, whose price index had a range going from 38 FF to 78 FF.

[11] The threshold was set at 20 observations after trying with several values. We think that this threshold keeps a reasonable number of products while eliminating those with the most severe effects.

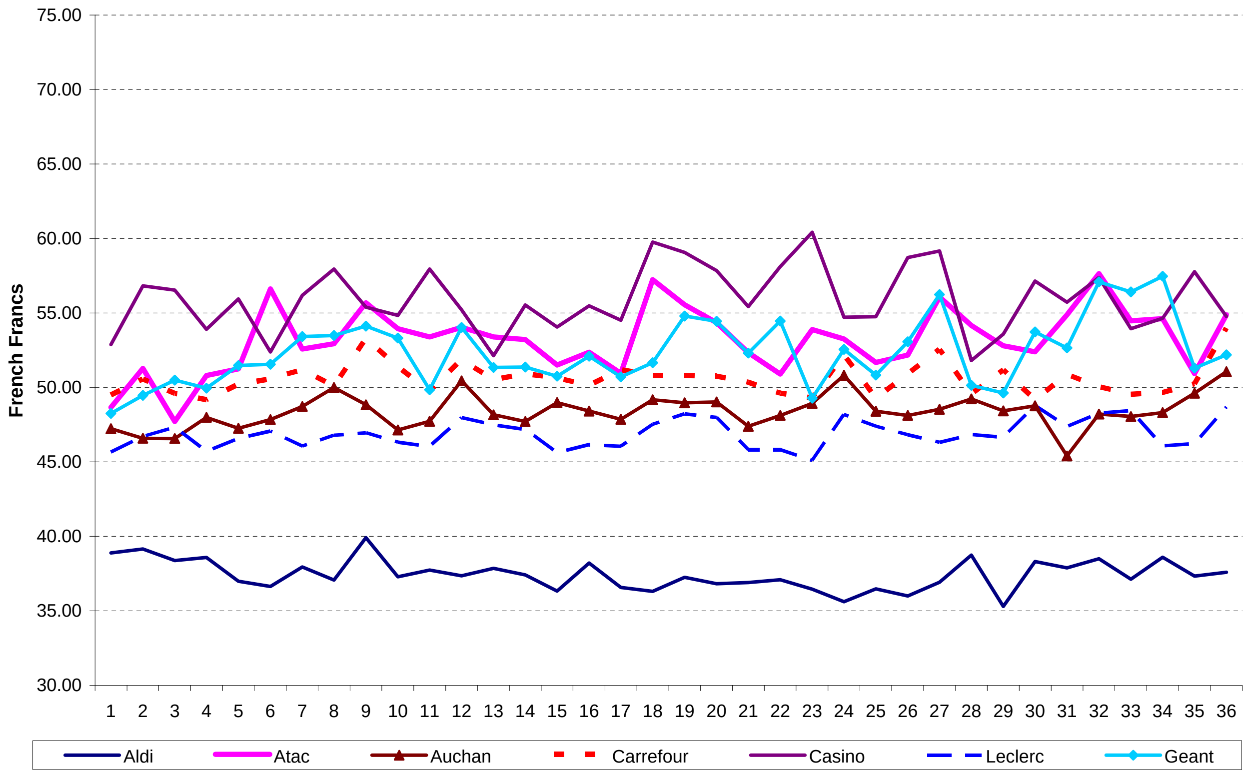

Figure 1: Evolution of retailer price index

all the consumers in the database, we expect this choice component to be mitigated. In a first stage, and given that the retailer choice model is estimated using data at the individual level, we will treat the price index as exogenous and test this assumption later.

6 Econometric Estimation

We begin this section with a discussion of the variables entering the different elements of the indirect utility. In addition to the household budget attributed to food (y_{it}) and the price of the basket of goods ($\widetilde{p}_{jt}$), variables in $\psi_{1jt}^{g(i)}$ are considered to affect both the choice of a retailer and the conditional expenditure of the consumer. Among them, retailer-speciffic characteristics include the ratio ρ_j of PL varieties to NBs in its assortment ($PLovNB$), its square and retailer fixed effects. These fixed effects capture observable and unobservable characteristics of retailers that are constant through individuals and time. The most important of these characteristics is the average perception of retailer's quality. $\psi_{1jt}^{g(i)}$ contains also individual-speciffic variables such as the possession of a car (*auto*) or the number of people in the household (nf).

The term $\psi_{2ijt}^{g(i)}$ chose the variables that may condition the consumer's choice of a retailer but not his/her expenditure. We include the distance between the individual and the retailer (*distance*), the logarithm of the average surface of the closest outlets belonging to the retailer (*lnavgsurface*) - this is a proxy for the total number of varieties, or the assortment, offered by the retailer at that outlet - and the number of competing retailers located less than 3 Km away from the consumer (*RinCatch3_comp*). The introduction of the other retailer characteristics presented in table 2 is in progress.

Finally, a second set of retailer fixed effects is included in $\phi_{2R}^{g(i)}$ to capture unobservable retailer characteristics that do not influence the conditional expenditure of the individual. As in Smith [2004], the identification of the two sets of fixed effects is possible because we observe both the retailer choice and the expenditure for every individual.

Given the complexity of the model to be estimated and to ease the computational burden, the choice set has been compressed into a smaller number of alternatives than those presented in the summary tables: the largest retailers are maintained, whereas all hard discounters in the sample and the minor hypermarket chains are grouped into two alternatives (*Hard discounters* and *Other hypermarkets*); the outside option is enlarged with the smallest supermarkets from table 2. This formulation assumes that retailers within the grouped alternatives are perfect substitutes for each other and that their unobserved characteristics, such as quality, are equally perceived by the consumers within these two kind of retailers. Hence, the two alternatives represent the aggregate competitive pressure that hard discounters and the rest of the minor hypermarkets put on the remaining retailers.

6.1 Identification issues

Demand parameters are obtained using simulated maximum likelihood (SML). Simulated choice probabilities are computed averaging the results from 100 random draws taken for every observation from a log-normal distribution $LN(0, \lambda^g)$. Simulation-based estimators require the draws to be fixed across the different iteration steps, so that the difference in the objective function for two different values of the parameters is not due to different draws (see Train [2003]). This requirement prevents us from estimating the parameter λ^g together with the rest of demand parameters. However, part of the parameters are already identified with the conditional expenditure equation (6). In particular, λ^g is identified and can be estimated by maximum likelihood estimation of this equation. The estimated value of λ^g is then used to define the distribution from which the random draws are taken. The whole discrete-continuous choice model is then estimated by SML (constraining λ^g to its first step value).

6.2 Substitution patterns and Independence from Irrelevant Alternatives

Simple logit models suffer from the property of independence from irrelevant alternatives (IIA), which generates proportionate substitution patterns among alternatives. In the present paper, more flexible substitution patterns are obtained by two different ways.

In the first place, the model is estimated separately per consumer types (g). Hence, the IIA holds for individuals within the same consumer type, but not at the aggregate level if a sufficient number of types is specified. These consumer types are defined in terms of income and location. SECODIP database classify individuals in 18 income categories and 7 different regions. We aggregate some of the income categories with the smallest number of observations (specially in the lowest and highest part of the income distribution), reducing the number of different income categories to 9. This yields 63 consumer types, although not all of them have enough observations to be able to estimate the model. Results are obtained for almost all types with income categories ranging from 4000 FF to 30000 FF.

A second source of flexibility is obtained by allowing for taste variation within consumer types. This is achieved by the interaction of individual and alternatives' characteristics. The addition of observable individual-speciffic variables in s_{it}, together with the unobservable ς_{it} and the functional form chosen for the indirect utility, provide these interactions. Hence, even at the consumer type level, the IIA does not hold for the aggregate.

6.3 Simultaneity bias

The estimation of demand for differentiated products may suffer from endogeneity problems analogous to those posed by homogeneous product analysis: producers will set all the control variables in their maximization problem (price and ρ_j, here) taking into account any demand shocks that they may observe. If these shocks are unobserved by the econometrician, then a simultaneity bias appears. In the context of differentiated products and discrete choice models, these shocks are product characteristics (in our case, retailer characteristics) that are unobservable or hardly measurable by the researcher. Among these characteristics, quality stands out as one of the most important. Other such characteristics proposed in the literature are past experience (Berry et al [1995]) or advertising and coupon activity (Besanko et al 1998).

To the extent that these characteristics are constant through time, the inclusion of retailer fixed effects in the indirect utility should remove this source of correlation from the error term. Hence, the coefficients of price and ρ_j would be unbiased. On the other hand, advertising or promotions can be thought as varying in time. Advertising is likely to be higher during weeks in which there is a promotion. Nevertheless, our time period being a month, we expect these two variables to be fairly constant through these aggregated time periods.

7 Results (in progress)

A summary of the results obtained for each consumer type is presented in table 3. Given the functional form chosen for the utility of the consumer, the interpretation of the coefficients cannot be read directly from the table. The exception are the coefficients of variables inside ψ_{2jt}, which enter the utility function linearly. As expected, distance to the retailer reduces the utility of every alternative. One would expect low-income consumers to be more willing to travel a certain distance in order to get a better price for their purchases. The fact that the negative effect of distance is less severe for high-income consumers may suggest that their costs of transportation are lower on average. The surface of the retailer has a positive effect on the utility of all the income classes, but specially for the high-income consumers. Since surface is a proxy for the assortment of the retailers, a higher estimate for its coefficient means that high-income consumers have a higher valuation for wider assortments. Finally, a higher number of retailers close to the consumer reduces the mean utility that he/she derives from each of them.

The interpretation of the rest of the parameters is best viewed by computing elasticities. Table 4 presents the different elasticities for each retailer.

Expected choice own-price elasticities are computed by averaging the simulated price elasticities of every consumer's retailer choice. Expected conditional demand own-price elast-

Averages across groups		Low Income			Medium Income			High Income		
		Coefficient	Sd. Error	Sd. Dev.	Coefficient	Sd. Error	Sd. Dev.	Coefficient	Sd. Error	Sd. Dev.
μ		0.0357	0.0186	0.0331	0.0164	0.0107	0.0311	-0.0138	0.0096	0.0241
β_1		32.2811	13.2880	27.5109	36.5074	11.7380	15.4747	40.5865	15.5978	20.8848
β_2		0.7065	0.0241	0.0478	0.6899	0.0167	0.0260	0.6662	0.0189	0.0284
ψ_1	PLovNB	-32.9577	27.7282	96.0753	-30.1491	27.0266	102.4588	77.1870	35.1050	79.3768
	PLovNB_sq	4.0410	2.6136	10.4881	2.3105	2.5083	11.9240	-8.6417	3.2072	10.8326
	Auchan	-100.8529	54.1861	171.5632	-37.9100	46.6841	76.0275	8.6871	167.2012	33.0036
	Carrefour	-75.2533	45.9186	133.3079	-55.4329	47.0703	89.0631	1.8252	166.0317	47.1788
	Champion	-82.2967	49.4105	136.3766	-67.0939	50.6627	106.2023	22.6440	168.7741	53.0365
	Intermarché	-38.7030	46.2224	138.1542	-50.9335	48.1499	116.0404	-39.7075	164.0654	23.8533
	Leclerc	-46.5822	44.5653	109.1177	-39.2306	45.8011	81.7047	-4.6275	164.4103	20.2025
	Others	-40.2720	46.7530	115.6687	-50.7909	48.9920	110.7522	-4.5563	167.0592	20.8583
	Other Hyperm.	-46.3982	48.6205	118.8934	-30.6969	52.4550	90.9347	-20.6770	169.2727	18.4644
	Hard Disct.	-71.2807	88.0823	162.9204	11.2117	77.7068	138.9468	-40.7482	252.2740	94.7411
α	auto	4.2094	21.4781	37.3770	3.6063	30.6502	48.3356	-64.0742	169.3693	26.5172
	nf	-2.5173	7.5050	21.4888	2.0173	5.4135	5.7374	-2.4922	8.0202	19.3949
ϕ_2	Auchan	2.2953	0.4079	0.1927	2.0879	0.3028	0.1916	1.9321	0.3305	0.2358
	Carrefour	2.3010	0.4065	0.1900	2.1023	0.3039	0.1449	1.9488	0.3310	0.2173
	Champion	2.2391	0.4187	0.2440	2.0941	0.3069	0.1563	2.0176	0.3273	0.2064
	Intermarché	2.2522	0.4054	0.1710	2.0844	0.3026	0.1671	1.9220	0.3298	0.2170
	Leclerc	2.2526	0.4057	0.1811	2.0846	0.3018	0.1673	1.8991	0.3309	0.2162
	Others	2.2847	0.4064	0.1786	2.1224	0.3032	0.1653	1.9678	0.3307	0.2213
	Other Hyperm.	2.3243	0.4066	0.1696	2.1269	0.3037	0.1678	2.0243	0.3338	0.2254
	Hard Disct.	2.1526	0.4065	0.1945	1.9772	0.3016	0.1305	1.8623	0.3254	0.1987
ψ_2	RinCatch3_comp	-0.0272	0.1908	0.6477	-0.6052	0.1391	0.5597	-0.3114	0.1250	0.1418
	distance	-0.6334	0.0747	0.2068	-0.6943	0.0651	0.4524	-0.4363	0.0420	0.1521
	lnavgsurface	0.1134	0.1867	0.4179	0.1071	0.1247	0.2607	0.1527	0.1328	0.4346
λ		0.0734	0.0094	0.0136	0.0812	0.0068	0.0130	0.1029	0.0080	0.0969

Table 3: Results of the discrete-continuous choice model across groups of consumers

v.28-04 sgrup	Own-price elasticity of choice	Own-price elasticity of conditional demand	Elasticity of PL/NB ratio on choice
Auchan	-4.0557	-1.0287	-0.3705
Carrefour	-4.5543	-0.9831	-0.4269
Champion	-4.1321	-1.0335	-0.5324
Intermarché	-3.6191	-1.0265	-0.6191
Leclerc	-3.6582	-1.0221	-0.4835
Others	-4.5684	-1.0180	-0.6956
Other Hyperm.	-5.1859	-0.9924	-0.4945
Hard Disct.	-3.5082	-1.1976	0.0104

Table 4: Elasticities implied by the choice model

icities are computed by averaging the simulated price elasticity of consumer's demand across consumers who did their primary shopping at retailer j. That is, the expected price elasticities are given by the following expressions:

$$\varepsilon_{jt}^{c} = \frac{1}{N} \sum_{i=1}^{N} \frac{\int \left[\partial s_{jt} \left(\varsigma \right) / \partial ln\, p_{jt} \right] dF \left(\varsigma \right)}{\int s_{jt} \left(\varsigma \right) dF \left(\varsigma \right)} \tag{23}$$

$$\varepsilon_{jt}^{x} = \frac{1}{N_j} \sum_{i=1}^{N_j} \frac{\int \left[\partial x_{jt} \left(\varsigma \right) / \partial ln\, p_{jt} \right] dF \left(\varsigma \right)}{\int x_{jt} \left(\varsigma \right) dF \left(\varsigma \right)} \tag{24}$$

Hard discounters face the lowest price elasticity for choice, indicating that their customers find the other options as being not so good substitutes. Thus, when confronted with a price increase, these customers react by cutting down on consumption. Although this seems a plausible behavior, the overall results on price elasticities are less convincing. Despite their higher conditional demand price elasticity, the net price elasticity (the addition of the two) is one of the more inelastic among the selected retailers. Similarly *Intermarché* and *Leclerc*, which advertise themselves as having lower prices, face net price elasticities as inelastic as those of Hard discounters. One would expect that these kind of stores appeal to more price-sensitive consumers, resulting in them facing a more elastic demand.

Elasticities with respect to ρ_j are computed in a similar way as price elasticities. Except for Hard discounters, all retailers see their choice probabilities decrease with an increase of this ratio. This is consistent with the ratio being seen as a signal for quality, with PLs decreasing the perceived quality of the retailer. The specification of the indirect utility function includes a quadratic term for the ratio. Since this term highlights high values of the ratio, its coefficient may be seen as mainly capturing the consumers' valuation of Hard Discounters' ratio. The result is that, to the eyes of the consumers, PLs are a good thing in Hard Discounters but a bad thing in the rest of retailers. The ρ ratio has the worst impact for *Intermarché* and the other small retailers whereas the less negative impact is found for *Auchan* and *Carrefour*. This findings seem reasonable in the sense that *Carrefour*'s PLs are viewed as being of higher quality than the rest.

Let us discuss in what follows the margins and derivatives implied by the assumed competition model between retailers. The results summarized in table 3 are used to construct the matrices X_p, S_p and Q, which are needed for the computation of the margins γ according to

v.28-04 sgrup		PL/NB ratio (ρ)
	Margin over sales	elasticity of costs
Auchan	14.86%	-0.2472
Carrefour	26.90%	0.2140
Champion	14.07%	-0.2512
Intermarché	18.01%	-0.4305
Leclerc	17.88%	-0.1932
Others		
Other Hyperm.		
Hard Disct.	12.91%	-2.0034

Table 5: Average estimates for margins and elasticities of costs to PL/NB ratio

the expression in (17). Given the compression of the choice set, none of the remaining retailers form a group[12]. Therefore, expression (17) is computed individually for the 8 alternatives above. Results are presented in table 5.

Estimated margins seem high in view of those estimated by Smith [2004] (around 10-13%) for the British market, whose concentration is similar to that of the French market[13]. The effect of product mix on retailers' marginal cost is estimated to be negative, except for Carrefour. For this retailer, having more PLs in the assortment relative to the number of NBs cause its marginal cost to increase.

Finally, to provide an indication of the consumers' substitution patterns between retailers, we compute their expected choice probabilities in the absence of Hard Discounters. We simulate the probability each consumer assigns to the retailers in his/her choice set, excluding the Hard Discounters. By the law of large numbers, the average of these choice probabilities across consumers, computed for every retailer, converges to the true choice probability they face. Table 6 presents the results of this simulation. Leclerc and, to a lesser extent, Intermarché would be the two most benefitted retailers. This finding seems realistic in the view that Leclerc heavily advertises its EDLP (Every Day Low Prices) pricing policy[14]. Thus, in the absence of Hard Discounters, consumers would preferably turn to other retailers they perceive as having lower prices. In this case, this decision implies travelling higher distances, since the most part of the consumers would switch to hypermarkets or large supermarkets

[12] Carrefour hypermarkets and Champion supermarkets are part of the Carrefour Group only since 2001, after the Carrefour-Promodés merger.

[13] According to ACNielsen data, the five largest retailers in UK hold a market share of 67% in 1999. In France this figure was around 72%. See *Rapport d'information sur l'évolution de la distribution*, Assemblée Nationale, 2000.

[14] See *Rapport sur l'évolution de la distribution*, op. cit.

v.28-04 sgrup	Original sample choice probability	Simulated choice probability	Difference (in percentage points)
Auchan	0.1570	0.1624	0.5
Carrefour	0.1359	0.1414	0.6
Champion	0.0539	0.0557	0.2
Intermarché	0.2536	0.2621	0.9
Leclerc	0.2795	0.2906	1.1
Others	0.0723	0.0745	0.2
Other Hyperm.	0.0369	0.0393	0.2
Hard Disct.	0.0360	0	–

Table 6: Simulated choice probabilities in the absence of Hard Discounters

located farther away. Supermarkets, like Champion, and other small retailers, although located closer to the consumer, would only take minor advantage of the absence of Hard Discounters.

8 Simulating retailer response to demand shocks (in progress)

In order to illustrate the applications of our proposed framework, we present in this section a simulation of the retailers' response to a demand shock. In particular, we consider the case of an increase in the transportation cost of all the consumers. Retailers located further away would be penalized relative to other closer retailers, such as supermarkets and Hard Discounters. In this case, models assuming only price competition between retailers would predict a price decrease for hypermarkets. However, if retailers can control, in addition to prices, their location in the characteristics space then the price decrease may be lower: retailers can compensate the increase in transportation costs by offering more quantity of the characteristics that are valued by the consumer. Of course the trade-off is determined by the costs of changing these characteristics. In our proposed framework, retailers can control their offering of PLs with respect to that of NBs and that, in turn, has an effect on their marginal costs.

We proceed to the simulation of an increase in transportation costs by simulating a 1% increase in the distance of the consumer to all the retailers. The exercise amounts to solve the system of equations formed by the first order conditions (13) and (19) with respect to prices and ρ_j. This requires the knowledge of the level of marginal costs as well as the value of the cost derivative along all the domain of the ratio. The level of marginal costs is obtained from

v.28-04 sgrup	Original price index	Original ρ ratio	Simulated price index	Simulated ρ ratio
Auchan	48.58	0.36	48.48	6.82
Carrefour	48.98	0.44	49.30	6.01
Champion	51.64	0.48	51.64	0.47
Intermarché	46.23	0.73		
Leclerc	48.60	0.53		
Others	53.87	0.43		
Other Hyperm.	51.79	0.37	51.41	6.10
Hard Disct.	37.81	7.08	41.22	3.36

Table 7: Retailers' reaction to an increase in transportation costs

the estimated margins as $\gamma_j - p_j$. As for the cost derivative, we assume that the derivative of marginal costs with respect to the ratio is constant. Its value is then given by the estimate of Γ_{PL}. The simulation is performed using the data for the last period of our sample. Results are given in table 7.

The high simulation ratios are a direct consequence of introducing a quadratic term for the ratio in the estimation of the indirect utility. Given that this quadratic term is positive, optimization calls for having large values of this ratio such that it plays positively both in the cost reduction but also in the choice probability. Of course this is not realistic. A better estimation of indirect utility is in progress.

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A Price Index

	Average expenditure per purchasing act	Weight
CHAMPAGNE (AVEC EAN)	146.26	3.9609%
WHISKY ET BOURBON AVEC EAN AVRIL 98	79.66	2.1572%
LAITS INFANTILES	61.43	1.6634%
FOIE GRAS CONDITIONNE (AVEC EAN)	58.64	1.5880%
RHUM	54.48	1.4753%
APERITIFS	52.75	1.4284%
ALCOOLS AUTRES	48.27	1.3072%
LAPIN (SANS EAN)	41.93	1.1355%
VEAU A BRAISER A BOUILLIR (SANS EAN)	40.91	1.1080%
MOUTON AGNEAU ROTIR/GRILLE/POEL(SANS EAN)	38.63	1.0460%
ESCARGOTS SURGELES	38.38	1.0395%
VEAU A ROTIR/GRILLER/POELER (SANS EAN)	37.16	1.0062%
BOEUF A ROTIR/GRILLER/POELER (SANS EAN)	36.59	0.9909%
MOUSSEUX ET PETILLANTS (AVEC EAN)	35.63	0.9648%
POULET ENTIER CRU (SANS EAN)	35.57	0.9633%
CRUSTACE MOLLUSQUE SURGELE	35.54	0.9625%
V.Q.P.R.D (AVEC EAN)	33.33	0.9026%
SAUMON FUME (AVEC EAN)	30.96	0.8385%
BOEUF A BOUILLIR A BRAISER (SANS EAN)	30.85	0.8354%
POISSON FRAIS (SANS EAN)	30.21	0.8181%
BROCHETTE VIANDE ET VOLAILLE	28.82	0.7804%
ROTI DE DINDE DINDONNEAU (SANS EAN)	28.78	0.7793%
VIN DE TABLE (SANS EAN)	28.73	0.7780%
CHEVAL A ROTIR/GRILLER/POELER (SANS EAN)	27.50	0.7448%
POISSON NON PANE SURGELE	27.35	0.7407%
HUILE D'OLIVE CONDITIONNEE	26.95	0.7299%
CHOCOLATS DE FETES&PERMANENTS EMBALLES	26.28	0.7117%
PORC A ROTIR/GRILLER/POELER (SANS EAN)	25.95	0.7028%
ABAT DE VEAU (SANS EAN)	25.93	0.7021%

Table 8: Most important product weights

	Avg. n. of nonmissing prices	n^o of prices in the index
Aldi	182.17	240
Atac	233.22	240
Auchan	237.28	240
Carrefour	237.19	240
Casino	229.94	240
CDM	198.66	240
Champion	235.13	240
Continent	210.83	240
Cora	234.92	240
Franprix	213.80	240
Geant	235.16	240
Hyper Champion	180.50	240
Hyper U	220.78	240
Intermarche	237.55	240
Leader price	228.44	240
Leclerc	238.11	240
Lidl	206.22	240
Mammouth	86.25	240
Monoprix	225.22	240
Super Monoprix	88.56	240
Super U	235.36	240
Outside option	238.19	240

Table 9: Non missing prices in each retailer's index