Demand system estimation with aggregated price index:
An application to the consumption of beverages at home in France in 1997

(working paper)

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INTRODUCTION

Demand systems are usually estimated using expenditure and quantities for aggregated products either because only aggregated data are available or because goods are so numerous that expenditure for and quantities of, different goods must be aggregated. In both cases, the price of an aggregated product is approximated by the ratio of expenditure to quantity. Deaton (1988) pointed out that the ratio of expenditure over quantity does not make a price but a unit value. The aggregation implies that the composite goods are made of commodities that are heterogeneous in quality. Two different households facing the same price system may have different unit values because the structure of their consumption inside the composite goods is different. Therefore, income and price elasticities reflect both a quantity effect and a quality effect. Moreover, unit values are endogenous. Deaton (1988), and more recently Crawford, Laisney and Preston (1996), proposed methods based on the a priori specification form of unit values that allow for the correction of the endogeneity of unit values and for separate estimation of quantity and quality elasticities with respect to prices. In the present work, we apply to beverages a methodology proposed by Nichèle and Robin (2000). They develop a fully structural model that associates the assumption of a Gorman polar form at the within-group utility level to the QAIDS assumption at the between-group utility level. They use a standard Paasche price index to aggregate within-group prices instead of the ratio expenditure to quantity, and thus avoid the problem of endogeneity of unit values.

1 - WEAK SEPARABILITY AND COLINEAR WITHIN-GROUP PRICES ASSUMPTIONS.

Following Deaton, Nichèle and Robin (2000) assume weak separability and colinearity of the prices inside the same group of products.

Assumption 1: Weak separability

The set of commodities can be partitioned into *G* mutually exclusive groups. Let $\mathbf{q}_i$ be the vector of demands corresponding to the set of commodities defining group *i*. Consumers' preferences are weakly separable. Specifically, each consumer solves the following program:

$$\max_{q_1,\dots,q_G} F(U_1(\boldsymbol{q}_1),\dots,U_G(\boldsymbol{q}_G))$$

under the budget constraint :

$$\sum_{i=1}^{G} \mathbf{p}_i'\mathbf{q}_i' = x$$

where $\mathbf{p}_i$ is the vector of prices of group *i* commodities.

Assumption 2: Colinearity of the prices inside the same group of products

In his work, Deaton defines the reference prices $\mathbf{p}_i^0$, like the prices observed in a particular geographical area of a particular sample. He defines λ_i as the multiplicative factor that must be applied to the present prices in the area of reference to obtain the present prices in another area at the same time.

More formally, there exists a set of *G* reference prices, such that for any vector of price $\mathbf{p}_i^0$, there exists a scalar λ_i such that:

$$\mathbf{p}_i = \lambda_i \mathbf{p}_i^0, \quad i = 1,\dots,G$$

Let

$$c_i(u_i, \mathbf{p}_i) = \min_{U_i(\mathbf{q}_i)=u_i} \mathbf{p}_i'\mathbf{q}_i$$

be the cost function for group *i*. Then assumption 2 implies that the total expenditure allocated to group *i* is :

$$\begin{aligned} x_i &= \mathbf{p}_i'\mathbf{q}_i \\ &= c_i(u_i, \mathbf{p}_i) \\ &= \lambda_i c_i(u_i, \mathbf{p}_i^0) \\ &= \lambda_i c_i^0(u_i) \quad \text{(say)} \end{aligned}$$

Moreover, the cost function being homogeneous of degree one in prices, the vector of demands for the commodities composing group *i* is :

$$\begin{aligned} \mathbf{q}_i &= \partial_p c_i(u_i, \lambda_i \mathbf{p}_i^0) \\ &= \partial_p c_i(u_i, \mathbf{p}_i^0) \end{aligned} \qquad (1)$$

where the operator ∂_p is the gradient with respect to price. Hence $\mathbf{q}_i$ also corresponds to the consumption vector of the same household facing price $\mathbf{p}_i^0$ when total expenditure x_i is compensated for the income effect of price scale changes.

The consumer allocation problem is then completed by substituting in equation (1) the values for $u_1,\dots,u_G$ solving the following maximization problem:

$$\max_{u_1,\dots,u_G} F(u_1,\dots,u_G) \qquad (2)$$

under the budget constraint :

$$\sum_{i=1}^{G} \lambda_i c_i^0(u_i) = x\ .$$

The total quantity consumed inside a group is the sum of all the quantities of the goods composing the group. The measuring unit may be different from one good to another.

We define for all i=1,...,G,

$$\begin{aligned} n_i &= \mathbf{k}_i'\mathbf{q}_i \\ &= \mathbf{k}_i'\partial_p c_i(u_i, \mathbf{p}_i^0) \end{aligned}$$

be a physical quantity index for group *i* . The vector $\mathbf{k}_i$ is a conversion factor. If the groups are physically homogeneous (all the commodities inside the same group are measured in the same unit, kilos for example), then the vector **ki** is a vector of ones.

Definition of a quality index

Let

$$\begin{aligned} l_i &= \frac{\mathbf{p}_i^{0\prime}\mathbf{q}_i}{\mathbf{k}_i'\mathbf{q}_i} \\ &= \frac{c_i^0(u_i)}{\mathbf{k}_i'\partial_p c_i(u_i, \mathbf{p}_i^0)} \end{aligned}$$

We thus obtain the usual decomposition of the expenditure :

$$x_i = \lambda_i l_i n_i$$

and it follows that the unit values $v_i = x_i/n_i$ are the product of the true price index λ_i and the quality index l_i:

$$v_i = \frac{x_i}{n_i} = \lambda_i l_i$$

Moreover, they define the cost of the utility u_i at reference price $\mathbf{p}_i^0$:

$$\begin{aligned} r_i &= c_i^0(u_i) \\ &= \mathbf{p}_i^{0\prime}\mathbf{q}_i \\ &= l_i n_i \end{aligned}$$

The greater the overall quality of a quantity n_i of group i is, the greater its cost at reference price. This term makes it possible thereafter to estimate quality elasticities and quantity elasticities at constant quality.

2 - The methodology of Nichèle and Robin (2000)

Nichèle and Robin (2000) develop a fully structural model that associates the assumption of a Gorman polar form at the within-group utility level to the QAIDS assumption at the between-group utility level. They use a standard Paasche price index to aggregate within-group prices instead of the ratio expenditure to quantity, and thus avoid the problem of endogeneity of unit values. Where Deaton specifies the form of the unit values, Nichèle and Robin deduce this form from there fully structural model[2].

Within-group budgeting

Nichèle and Robin (2000) assume that the intra-group allocation processes derived from a cost function of Gorman polar form :

$$c_i(u_i, \mathbf{p}_i) = \mathbf{a}_i'\mathbf{p}_i + u_i \exp[\mathbf{b}_i' \ln \mathbf{p}_i] \qquad (3)$$

[2] We do not give the deduced form of unit values because it is not our purpose here. To have this form cf. Nichèle and Robin (2000).

where $\mathbf{a}_i'\mathbf{p}_i^0$ represents the cost of living when u_i is zero.

As $\mathbf{p}_i = \lambda_i \mathbf{p}_i^0$ and $c_i(u_i, \mathbf{p}_i) = \lambda_i c_i(u_i, \mathbf{p}_i^0)$ with i = 1, ..., G, then

$$c_i(u_i, \mathbf{p}_i^0) = \mathbf{a}_i'\mathbf{p}_i^0 + u_i \exp[\mathbf{b}_i' \ln \mathbf{p}_i^0]$$

or

$$c_i^0(u_i) = a_i^0 + b_i^0 u_i$$

with $a_i^0 = \mathbf{a}_i'\mathbf{p}_i^0$ and $b_i^0 = \exp[\mathbf{b}_i' \ln \mathbf{p}_i^0]$.

As $x_i = \lambda_i c_i^0(u_i)$, then

$$x_i = \lambda_i a_i^0 + \lambda_i b_i^0 u_i$$

From this specification, they deduce the form of the quality and quantity index. The derivative of the cost with respect to price is written:

$$\partial_{\mathbf{p}} c_i(u_i, \mathbf{p}_i^0) = \mathbf{a}_i + (\mathbf{b}_i æ\ \mathbf{p}_i^0) b_i^0 u_i$$

where $(\mathbf{b}_i æ\ \mathbf{p}_i^0)$ is a vector obtained by dividing each element of $\mathbf{b}_i$ by each element of $\mathbf{p}_i^0$ (Hadamard vector division). Hence, the quantity index is written:

$$\begin{aligned} n_i &= \mathbf{k}_i'\partial_{\mathbf{p}} c_i(u_i, \mathbf{p}_i^0) \\ &= \mathbf{k}_i'\mathbf{a}_i + \mathbf{k}_i'(\mathbf{b}_i æ\ \mathbf{p}_i^0) b_i^0 u_i \end{aligned}$$

and the quality index :

$$l_i = \frac{c_i^0(u_i)}{\mathbf{k}_i' \partial_{\mathbf{p}} c_i(u_i, \mathbf{p}_i^0)}$$

$$= \frac{a_i^0 + b_i^0 u_i}{\mathbf{k}_i'\mathbf{a_i} + \mathbf{k}_i'(\mathbf{b}_i æ\, \mathbf{p}_i^0) b_i^0 u}$$

$$= \frac{1}{n_i}\left(a_i^0 + \frac{n_i - \mathbf{k}_i'\mathbf{a_i}}{\mathbf{k}_i'(\mathbf{b}_i æ\, \mathbf{p}_i^0)} \right)$$

BETWEEN-GROUP BUDGETING

Under assumption 3, the first-stage allocation problem (2) then becomes:

$$\max_{u_1,\ldots,u_G} F(u_1,\ldots,u_G)$$

under the budget constraint

$$\sum_{i=1}^{G} \lambda_i b_i^0 u_i = x - \sum_{i=1}^{G} \lambda_i a_i^0$$

or equivalently

$$\max_{r_1,\ldots,r_G} F\left(\frac{r_1 - a_1^0}{b_1^0}, \ldots, \frac{r_G - a_G^0}{b_G^0} \right)$$

under the budget constraint

$$\sum_{i=1}^{G} \lambda_i r_i = x$$

Nichèle and Robin (2000) assumes that the direct utility function of the preceding problem of maximisation is of Quadratic AIDS type (see Banks, Blundell and Lewbel, 1997). Therefore, the associated cost function :

$$c(u, \pi_1, \ldots, \pi_G) = \min_{u_1,\ldots,u_1} \sum_{i=1}^{G} \pi_i u_i$$

with

$$F(u_1,\ldots,u_G) = u$$

is of the form

$$\ln c(u, \pi) = a(\pi) + b(\pi)\left[d(\pi) + u^{-1} \right]^{-1}$$

where $\boldsymbol{\pi} = (\pi_1, \ldots, \pi_G)$ and where

$$a(\pi_1, \ldots, \pi_G) = \alpha_0 + \sum_{i=1}^{G} \alpha_i \ln \pi_i + \frac{1}{2} \sum_{i,j=1}^{G} \gamma_{ij} \ln \pi_i \ln \pi_j$$

$$\ln b(\pi_1, \ldots, \pi_G) = \sum_{i=1}^{G} \beta_i \ln \pi_i$$

$$d(\pi_1, \ldots, \pi_G) = \sum_{i=1}^{G} \tau_i \ln \pi_i$$

Then

$$\frac{\lambda_i b_i^0 u_i}{x - \sum_{i=1}^{G} \lambda_i a_i^0} = \alpha_i + \sum_{j=1}^{G} \gamma_{ij} \left[\ln \lambda j + \ln b_j^0 \right]$$
$$+ \beta_i \left[\ln\left(x - \sum_{i=1}^{G} \lambda_i a_i^0 \right) - a(\lambda_1 b_1^0, \ldots, \lambda_G b_G^0) \right]$$
$$+ \frac{\tau_i}{b(\lambda_1 b_1^0, \ldots, \lambda_G b_G^0)} \left[\ln\left(x - \sum_{i=1}^{G} \lambda_i a_i^0 \right) - a(\lambda_1 b_1^0, \ldots, \lambda_G b_G^0) \right]^2$$

Alternatively, since

$$x_i = \lambda_i a_i^0 + \lambda_i b_i^0 u_i$$

and denoting

$$y = x - \sum_{i=1}^{G} \lambda_i a_i^0$$

$$s_i = \frac{x_i}{y}$$

one has equivalently that :

$$s_i = a_i^0 \frac{\lambda_i}{y} + \tilde{\alpha}_i + \sum_{j=1}^{G} \gamma_{ij} \ln \lambda_j + \beta_i [\ln y - \tilde{a}(\lambda_1,\ldots,\lambda_G)] + \frac{\tilde{\tau}_i}{b(\lambda_1,\ldots,\lambda_G)} [\ln y - \tilde{a}(\lambda_1,\ldots,\lambda_G)]^2 \quad (4)$$

where

$$\tilde{\alpha}_i = \alpha_i + \sum_{j=1}^{G} \gamma_{ij} \ln b_j^0$$

$$\tilde{\tau}_i = \frac{\tau_i}{b(b_1^0,\ldots,b_G^0)} = \frac{\tau_i}{\exp \sum_{j=1}^{G} \beta_j \ln b_j^0}$$

and

$$\tilde{a}(\lambda_1,\ldots,\lambda_G) = \tilde{\alpha}_0 + \sum_{i=1}^{G} \tilde{\alpha}_i \ln \lambda_i + \frac{1}{2} \sum_{i,j=1}^{G} \gamma_{ij} \ln \lambda_i \ln \lambda_j$$

with

$$\tilde{\alpha}_0 = \alpha_0 + \sum_{i=1}^{G} \alpha_i \ln b_i^0 + \frac{1}{2} \sum_{i,j=1}^{G} \gamma_{ij} \ln b_i^0 \ln b_j^0$$

s_i is the share of the outside cost of living total expenditure allocated to the commodities group *i* .

ELASTICITIES

Price- and expenditure-elasticities of bundle costs at reference price

They define the expenditure-elasticities of bundle costs at reference price as:

$$\left.\frac{\partial \ln r_i}{\partial \ln x}\right|_{\lambda} = \frac{x}{y} \left[1 + \frac{1}{s_i} \left(\beta_i + 2\tilde{\tau}_i \frac{\ln y - \tilde{a}(\lambda_i,\ldots,\lambda_G)}{b(\lambda_i,\ldots,\lambda_G)} - \frac{a_i^0 \lambda_i}{y} \right) \right]$$

Uncompensated price-elasticities of bundle costs at reference price are:

$$\left.\frac{\partial \ln r_i}{\partial \ln \lambda_j}\right|_{x} = \left(-\delta_{ij} + \frac{a_i^0 \lambda_i}{y} \right) + \frac{1}{s_i} \left[\frac{a_i^0 \lambda_i}{y} \left(\delta_{ij} + \frac{a_i^0 \lambda_j}{y} \right) + \gamma_{ij} - \tau_i \frac{[\ln y - \tilde{a}(\lambda_i,\ldots,\lambda_G)]^2}{b(\lambda_i,\ldots,\lambda_G)} \beta_j - \left(\beta_i + 2\tilde{\tau}_i \frac{\ln y - \tilde{a}(\lambda_i,\ldots,\lambda_G)}{b(\lambda_i,\ldots,\lambda_G)} \right) \left(\tilde{\alpha}_j + \sum_{k=1}^{G} \frac{\gamma_{kj} + \gamma_{jk}}{2} \ln \lambda_k + \frac{a_j^0 \lambda_j}{y} \right) \right]$$

And compensated price-elasticities of bundle costs at reference price are obtained using the usual formula:

$$\left.\frac{\partial \ln r_i}{\partial \ln \lambda_j}\right|_{u} = \left.\frac{\partial \ln r_i}{\partial \ln \lambda_j}\right|_{x} + \omega_j \left.\frac{\partial \ln r_i}{\partial \ln \lambda_j}\right|_{\lambda}$$

where $\omega_j = \frac{x_j}{x} = s_j \frac{y}{x}$ is the exact budget share of group j.

Price- and expenditure-elasticities of quantities

As

$$\begin{aligned} n_i &= \mathbf{k}_i'\mathbf{a_i} + \mathbf{k}_i'\left(\mathbf{b}_i \text{æ}\, \mathbf{p}_i^0\right)b_i^0 u_i \\ &= \mathbf{k}_i'\mathbf{a_i} + \mathbf{k}_i'\left(\mathbf{b}_i \text{æ}\, \mathbf{p}_i^0\right)\left(r_i - a_i^0\right) \end{aligned} \quad (5)$$

It thus follows that

$$\begin{aligned} \frac{\partial \ln n_i}{\partial \ln r_i} &= \frac{r_i}{n_i}\mathbf{k}_i'\left(\mathbf{b}_i \text{æ}\, \mathbf{p}_i^0\right) \\ &= l_i \mathbf{k}_i'\left(\mathbf{b}_i \text{æ}\, \mathbf{p}_i^0\right). \end{aligned}$$

Hence all elasticities of quantities are obtained from the corresponding elasticities of bundle costs at reference price by the multiplication by factor $l_i \mathbf{k}_i'\left(\mathbf{b}_i \text{æ}\, \mathbf{p}_i^0\right)$. An estimate of $l_i \mathbf{k}_i'\left(\mathbf{b}_i \text{æ}\, \mathbf{p}_i^0\right)$ is necessary in order to compute these elasticities. It can be obtained by regressing n_i on $r_i - a_i^0$ or r_i using equation (5).

Price- and expenditure-elasticities of qualities

Since

$$r_i = n_i l_i$$

elasticities of qualities are obtained by substracting elasticities of quantities from the elasticities of bundle costs at reference price.

3 - THE ESTIMATION METHOD

The system (2) is linear in $a_i^0, \tilde{\alpha}_i, \gamma_{ij} \text{ et } \beta_i$ conditional on $s_i, y \text{ et } \tilde{a}(\lambda_1,...,\lambda_G)$ being known functions. The method proposed to estimate system (4) is the Iterated Least Squares estimator for conditionally linear systems (see Blundell and Robin, 1999). In the first stage, s_i is replaced by exact share $w_i = x_i / x$, y exact total outlay x, and index $\tilde{a}(\lambda_i,...,\lambda_G)$ by a Stone index $\sum_{i=1}^{G} \overline{w_i} \ln \lambda_i$, where $\overline{w_i}$ is the mean share of group i in the sample and the modified system is estimated by linear least squares. This provides initial values to start the iterations. Each iteration consists in reevaluating $s_i, y \text{ et } \tilde{a}(\lambda_1,...,\lambda_G)$ and $b(\lambda_i,..., \lambda_G)$ using the estimates from the previous step, and in reestimating system (4) using the evaluation of $s_i, y \text{ et } \tilde{a}(\lambda_1,...,\lambda_G)$ and $b(\lambda_i,..., \lambda_G)$. The iterations are repeated until numerical convergence. Individual heterogeneity is introduced through the parameters α_i as a linear function of the household's characteristics, $\alpha_i = A_i \mathbf{z}$. The total expenditure endogeneity is corrected introducing the residual of an instrumental regression in each share equation as an intercept.

4 - THE DATA

The data are extracted from a French households panel collected by SÉCODIP (*Société d'Étude de la Consommation, Distribution et Publicité*) in 1997. They contain information on the characteristics of households living in France and on their daily food purchases. Each household records the characteristics of each product which it bought using a bar code scanner. The reading is done directly on the packaging of the product if indeed it has bar code. The characteristics of the products without bar code, like wine bought from the producer, are recorded following a menu on the screen of bar code scanner. Therefore the product's characteristics are recorded in as much detail as possible. This permits an almost total elimination of the unspecified codes. We chose to work with data of the year 1997 for several reasons. Before 1996, completely distinct households recorded alcoholic and non-alcoholic beverages. It was impossible to consider a complete demand system for drinks. Moreover, men living alone were not surveyed. Until 1996, the panelists noted their weekly purchases in a notebook; starting from this date, the purchases are recorded daily as described previously and all types of households are surveyed. The year 1997 is the first year for which the new system is stabilized. Moreover, it is the most recent year we have. The purchases were grouped per quarter to take account of possible seasonal variations in the structure of drink expenditure, and to avoid the problem of purchase rhythms. To estimate a demand system permits to highlight the household' s reactions to price or total expenditure variations and possible substitutions between drinks. The interest of panel data compared to survey data, where the households are followed only during a short period, is that we distinguish for sure, which products are and aren't bought. Therefore, there is no problem of the frequency of purchase. First, consider large groups of drinks, which all of which contain all the levels of quality and prices for a product of comparable nature. A household that does not buy of one group can be regarded as a non-buyer of the corresponding product. The price is not the reason of the non-purchase. Therefore only "real" zeros are observed. They correspond to an absence of durable consumption. This one can be due to an aversion to the product, to autosupply, homemade production or to consumption away from home. A household that does not like a category of drinks, like alcohol for example will not buy of this product, even if the price strongly decreases. Perhaps they do not even know the price. Each household entering in the estimate of a demand system is assumed to know the price index of all the groups of commodities between which they allocate their total expenditure. Each household is supposed to take part in the market, i.e. to be an effective consumer or at least a potential buyer of each group of products constituting the demand system. Then, if no purchase is observed for one or more groups, the cause is too high a price. If the household does not buy one or more products because they do not appreciate to consume them, the price is not an explanatory variable of the purchase behavior. To eliminate the households not taking part in the markets, we first regrouped drinks in sufficiently broad groups so that too high a price cannot be a reason for non-consumption. In this way, we retain only the households which "are really concerned" with the consumption of the whole range of beverages. We think it is better to calculate elasticities that well reflect the direct and crossed reactions between the prices and the demand of the different products. To carry out the selection of the households, we first chose the 3230 households for which the entire range of the purchases of drinks is observed. We regrouped beverages in five main categories: alcohol, wines including sparkling wines, beer including shandy, bottled water, other drinks without alcohol. Only the households in the market were retained. Those which, during the year, do not buy one of the five main categories of drinks, were withdrawn from the study. This restriction resulted in retaining 2306 among the initial 3230 households. This selection implies a proportionally more significant suppression of households made up of only one person compared to the other categories of households. The probability that the person living alone buy all five categories of drinks is weaker than for the households made up of several people. Consequently the results are representative of the households purchasing the five categories of drinks.

Once the selection carried out, we can admit that inside each large group of drinks, some of the varieties that compose the groups are not consumed by every household because of their prices. It then becomes interesting to split some of the five groups to constitute new ones, containing each one a more restricted number of products. The purchases of drinks of the 2306 selected households were distributed into nine classes. These classes are table wines, country wines, appellation wines, sparkling wines and cider, other alcohol, beer, bottled water, non-carbonated soft drinks and carbonated soft drinks. Contrary to the preceding stage, this time a household can buy nothing in one or more of the nine classes. We try as much as possible to avoid non-purchases due to the taste of the households. For example, although cola is a heavily consumed drink and it could constitute a group by itself, we have regrouped it with other carbonated soft drinks. Indeed some households can not like cola. To build a price index, each of the nine groups was subdivided in homogeneous varieties of drinks (cf. Annexe A.1). We try as much as possible, inside the groups, to order drinks according to their nature and their quality. For example, for non carbonated soft drinks we constituted the following homogeneous sub-groups in decreasing quality: fresh pure juices, preserved pure juices, juice containing concentrate, nectars, fruited non carbonated soft-drinks. We can consider that this order is objective because it was not made according to the price of the products, but to the idea of quality that we can have. Nevertheless the order of prices is coherent with that of quality. The higher the quality of the product, the more expensive it is on average. Country wines were classified according to the denomination zone, the area or department, the last representing the lowest of three qualities (cf Annexe A.1). As we do have neither the year nor the name of the producer or of the trader and that we do not know if it is a first vintage or a great vintage (except in certain cases where the name of the great vintage is indicated), the V.Q.P.R.D[3] were classified according to their area of production and the classifications authorized in the village. The purpose of the hierarchical structure we retained is to be generally applicable to all the areas. For example, the wines of Gevrey-Chambertin are not classified as wines from "la Côte de Nuits" but as wines of a village where great vintages are authorized. Then it is possible to compare them with wines of corresponding quality like wines from "Saint-Estèphe". Nevertheless, they were not grouped together although they are of equivalent quality. Not being produced in the same area nor with the same grapes, they are not homogeneous. The classification being rather different from one area to another, regroupements take into account certain regional characteristics. Only for Bordeaux, Burgundies and wines from the Alsace can we constitute a group "great vintages" and a group "first vintages". In order of decreasing quality, the classification is the following one: Great vintages and wines having the name of a village where great vintages are produced (for the Alsace, great vintages or grapes authorized for great vintages), wines with the name of a village where first vintages are produced, vintages, "village" appellation followed by the name of the commune, "village" appellation only, sub-regional appellations, regional appellations, V.D.Q.S.[4]. A "primeur" category was constituted. Dessert wines and the "yellow wines" were distributed into two categories, high quality and other quality. Foreign wines for which we have no information are classified according to their origin. For sparkling wines, the higher quality is Champagne and the lowest sparkling wine without appellation. The group "other alcoholic drinks" consists of heterogeneous products like spirits, liqueurs, and liqueur wines or alcoholic mixed drinks. We tried nevertheless to constitute an objective hierarchy of coherent quality with the average prices by nature of product. For example, for the whiskies, the blends represent the lowest quality and the singles the best. For the group of table wines, the only sign of quality seemed to be the packaging. We can suppose that a table wine sold in a glass bottle of 0,75 cl, looking like appellation wines, will be perceived as being of better quality by the consumer than wine sold in a plastic bottle. Bottled waters are classified according to their minerality. We may assume that spring water, carbonated or not, is perceived as being of worse quality than mineral water. For beer, the two most consumed categories are luxury beers and the specialties, the first being of lowest quality than the seconds. The group containing carbonated drinks could not be ordered like the other groups. It would be necessary to detail the marks, which was not possible to us.

To construct the price index, the ratio $x_{it}^{h} / \mathbf{p}_{i}^{0\prime} \mathbf{q}_{it}^{h}$ is calculated. It is a Paasche price index by household, quarter and group of beverages. $\mathbf{p}_{i}^{0}$ is the vector of reference prices, *i* the group of goods, *h* the household, *t* the quarter, x_{it}^{h} the total expenditure for the purchase of drinks of group *i* by household *h* during quarter. $\mathbf{q}_{it}^{h}$ is the vector of quantities bought by household *h* during quarter *t*. These quantities are the different homogeneous commodities composing group *i*. For example, let us take country wines. The group comprehends country wines of different denominations i.e. area, zone or department. Let us admit that household *h* during quarter *t* buys area and department wines. The index of the aggregate price of country wines for household *h* during quarter *t* is calculated in the following way:

$$\lambda_{it}^{h} = \frac{\text{Total expenditure of country wine households}}{\text{Expenditure of the household if bought wines would be paid at the reference price}}$$

We uses λ_{it}^{h} instead of usual unit values. Price indexes are replaced by their averages calculated by quarter, the group of products, department and category of commune. We do that to avoid effects due to differences in the distribution network.

[3]Quality wine producted in a specific area.
[4] Wine of superior quality.

5 - RESULTS

Table 5.1 expenditure elasticities and others coefficients.

Groups of drinks	Calculated budget shares in %	Total expenditure elasticities of quantity	Total expenditure elasticities of quality	β_i Deflate Total expenditure	τ_i Quadratic term	Correction of endogeneity
Table wine	4.1	0.028 (0.27)	0.011 (0.13)	0.016 (0.77)	-0.004 (-2.87)	0.032 (3.97)
Country wine	4.1	0.804 (3.13)	0.127 (0.98)	0.054 (2.57)	-0.005 (-3.32)	0.008 (1.06)
Appellation wine	15.5	0.988 (8.44)	0.508 (2.79)	0.041 (0.99)	0.005 (1.70)	-0.023 (-1.58)
Sparkling wine and cider	6.9	0.862 (5.32)	0.716 (2.79)	-0.089 (-2.84)	0.011 (4.93)	-0.017 (-1.64)
Other alcoholic drinks	20.7	0.759 (6.72)	0.153 (1.40)	-0.022 (-0.45)	0.001 (0.27)	0.066 (4.05)
Beer	9.3	0.407 (1.95)	0.038 (0.42)	-0.002 (-0.06)	-0.003 (-1.71)	0.044 (4.61)
Bottled water	14.3	1.273 (2.80)	-0.138 (-0.29)	0.019 (0.36)	-0.001 (-0.35)	-0.077 (-5.64)
Non-carbonated soft drinks	17.0	0.943 (5.15)	-0.203 (-1.43)	-0.068 (-1.60)	0.002 (0.55)	-0.026 (-2.29)
Carbonated soft drinks	8.0	1.020 (1.56)	-0.188 (-0.39)	0.051 (1.48)	-0.006 (-2.13)	-0.007 (-0.89)

Significant level 5%, in grey. T of Student in parenthesis.

Interpretation of the quadratic term

The results (cf table 5.1) show that for four of the nine groups of drinks, the coefficient τ_i is significantly different from zero. The groups are table wines, country wines, sparkling wine and cider, and carbonated soft drinks. For table wines, country wines, and carbonated soft drinks the coefficient is negative. That means that the share of these drinks in the total expenditure decreases after a certain amount of the expenditure. For sparkling wines the coefficient is positive. Then, after a certain amount, the share of sparkling wines increases in the total expenditure.

Total drink expenditure elasticities of quantity

Bottled water has an expenditure elasticity higher than one. Thus, the quantity of these products vary more than proportionally when the budget allocated to beverages varies. Soft drinks and appellation wines have an expenditure elasticity near to the unit. Country wines, sparkling wines and cider, and others alcoholic drinks have an expenditure elasticity lower than one. The quantity demanded for these products vary less than proportionally when the budget allocated to drinks varies. Expenditure elasticity of table wines and carbonated soft drinks is not significant. That of beer is significant at 10% and indicates that the demand for this product is not very sensitive to the variations of the total expenditure.

Total drink expenditure elasticities of quality

Only elasticities of the groups "appellation wines" and "sparkling wines and ciders" are significant. All the others are clearly nonsignificant. When the total expenditure allocated to the purchase of beverages increases, the households buy a greater quantity and a better quality of appellation wines and sparkling wines and ciders. Quality elasticity accounts for 34% of the total effect (where quantity and quality effect are confused) for appellation wines and 45% for sparkling wines and ciders. When the total expenditure increases, households privilege the increase in quantity in the purchase of appellation wines, whereas for sparkling wines the increase in quality is at the same level as the increase in quantity.

Price elasticities of quantity

Table 5.2 : Compensated price elasticities of quantity

Groups of beverages	Table wines	Country wines	Appellation wines	Sparkling wines	Other alcoholic beverages	Beer	Bottled water	Non-carbonated soft drinks	Carbonated soft drinks
Table wines	-0,696 (-1,78)	0,083 (1,89)	0,120 (2,07)	0,129 (1,79)	-0,160 (-1,40)	0,011 (0,14)	0,236 (4,29)	0,244 (3,94)	0,032 (1,07)
Country wines	0,083 (1,63)	-0,839 (-4,66)	0,088 (1,16)	0,196 (2,36)	0,131 (1,02)	0,055 (0,89)	0,152 (1,57)	0,100 (1,00)	0,033 (0,39)
Appellations wines	0,022 (2,75)	0,017 (0,94)	-0,381 (-2,51)	0,033 (1,06)	0,102 (5,67)	0,010 (0,91)	0,146 (2,92)	0,017 (1,13)	0,034 (0,62)
Sparkling wine	0,044 (1,42)	0,070 (2,19)	0,066 (1,06)	-0,373 (-3,93)	0,038 (1,73)	0,130 (4,81)	0,046 (0,75)	0,002 (0,03)	-0,024 (-0,53)
Other alcoholic drinks	-0,032 (-1,88)	0,027 (1,29)	0,113 (2,09)	0,022 (0,65)	-0,510 (-4,81)	0,056 (2,00)	0,132 (1,83)	0,122 (6,10)	0,070 (2,80)
Beer	0,006 (0,17)	0,030 (0,79)	0,029 (0,63)	0,208 (3,71)	0,153 (2,25)	-0,894 (-3,36)	0,155 (2,54)	0,196 (5,03)	0,117 (2,29)
Bottled water	0,082 (2,00)	0,053 (1,56)	0,277 (6,60)	0,046 (1,77)	0,227 (3,49)	0,097 (1,90)	-1,165 (-12,26)	0,257 (4,59)	0,126 (1,20)
Non-carbonated soft drinks	0,097 (1,94)	0,040 (0,98)	0,038 (0,48)	0,004 (0,07)	0,240 (1,92)	0,140 (2,59)	0,296 (2,79)	-0,910 (-5,95)	0,056 (0,45)
Carbonated soft drinks	0,025 (0,54)	0,025 (0,57)	0,135 (0,51)	-0,052 (-1,08)	0,263 (3,21)	0,161 (1,75)	0,275 (4,23)	0,107 (1,01)	-0,938 (-1,59)

T of Student in parenthesis; Significant level at 5% in grey (light grey = direct price elasticities, dark grey = crossed price elasticities).

Direct price elasticities of quantity

Direct compensated price elasticities located on the diagonal of table (5.2) are all negative in accordance with the theory. Table wines and carbonated soft drinks have a nonsignificant direct price elasticity of quantity. The demand for appellation wines, sparkling wines and others alcoholic drinks is hardly elastic. An increase of prices of these drinks involves only a weak reduction in the bought quantity. The demand for country wines, beer and soft drinks is slightly more elastic. Only the elasticity of bottled water is greater than one.

Crossed price elasticities of quantity

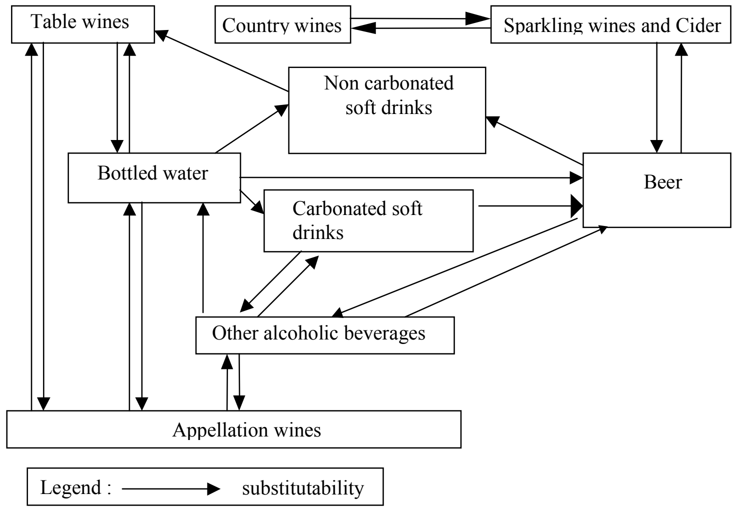

Diagram 5.1: The substitutabiliy between groups of beverages.

Outside the diagonal, table (5.2) contains compensated crossed price elasticities of the quantity. They measure the variation of the quantity demanded for a good after a variation of the price of another good, with constant real expenditure. There are no negative compensated crossed price elasticities. Therefore, there are no complementary drinks. Diagram (5.1) presents in a synthetic way substitutions between significant drinks at level 5%. Table wines are substitutable by appellation wines and bottled water, country wines by sparkling wines. Appellation wines have table wines, other alcoholic drinks and bottled water as substitutes. Sparkling wines have country wines and beer for substitutes. Other alcoholic drinks are substitutable by appellation wines, beer, bottled water and carbonated soft drinks. Beer is substitutable by sparkling wines, other alcoholic drinks and non carbonated soft drinks. Bottled water is substitutable by all other drinks, except country wines, sparkling wines and other alcoholic drinks. Non carbonated soft drinks have table wines, other alcoholic drinks, beer and bottled water for substitutes. Carbonated soft drinks are substitutable by other alcoholic drinks and beer.

Direct compensated price of quality

Table 5.3: Direct compensated price elasticities of quality

Groups of drinks	Table wine	Country wine	Appellation wine	Sparkling wine	Other alcoholic drinks	Beer	Bottlened water	Non carbonated soft drinks	Carbonated soft drinks
Elasticity price of quality	-0,269 (-1,10)	-0,132 (-0,75)	-0,196 (-1,54)	-0,310 (-3,20)	-0,103 (-1,66)	-0,083 (-0,38)	0,126 (0,31)	0,196 (2,13)	0,173 (0,39)

T of Student in parenthesis; Significant level at 5%, in grey.

Table (5.3), presents the compensated direct price elasticities of quality. Except those of sparkling wines and cider and non carbonated soft drinks, they are nonsignificantly different from zero. When the price of sparkling wines increases, households buy sparkling wines of lower quality. When the price of non carbonated soft drinks increases, they increase the quality of these drinks. A plausible explanation of these results is that in the case of sparkling wines, the difference in price between qualities is large (several times ten francs), whereas in the case of non carbonated soft drinks, it is close (a few francs). In other words, for drinks characterized by great differences in price between qualities, when the price increases the consumers decrease at the same time the bought quantity and quality. On the other hand, for drinks characterized by weak differences in price between qualities, when the price increases, the consumers buy a smaller quantity but a better quality. We can suppose that in this second case the price difference between two successive qualities is not sufficiently dissuasive to deprive the household of higher quality.

CONCLUSION

The methodology suggested by Nichèle and Robin (2000), allows to identify the quantity and quality components of elasticity, but it does not modify basically the results obtained with an estimate of a QAIDS with unit values (cf. Boizot 2000). In both cases we arrive at similar conclusions on the typology of drinks and we find the same overall substitutions overall. Except beer and other alcoholic drinks all the beverages can be considered as table drinks. Sparkling wines and cider, carbonated soft drinks, beer and other alcoholic drinks are a priori more particularly present on festive occasions and at festive meals, as aperitif or digestive, when households receive parents or friends. Non carbonated soft drinks, bottled water, carbonated soft drinks and beer can, because of substitutions, be considered as refreshment drinks. We can thus retain the three same possible situations of use as with a usual demand system estimation: ordinary meal, conviviality, thirst. Non carbonated soft drinks and bottled water are the drinks of all these situations. Beer and carbonated soft drinks are conviviality and refreshment drinks.

The calculation of elasticities of quality with respect to the total drink expenditure shows that households saturate more quickly in their consumption of sparkling wines than in their consumption of appellation wines. Indeed, when the total expenditure allocated to drinks increases, they increase the quantity as much as the quality for sparkling wines, but increase more the quantity than the quality for appellation wines. Direct compensated price elasticities of quality also show that when the quality is not very distant in price from a higher quality for similar products, as is the case for non carbonated soft drinks, a rise in the price of the first involves a transfer of the purchase to the second. The method implemented in this article leads not only to the same conclusions as the usual method (with unit values), but also adds new information on the behavior of households in an increasingly significant field: that of the arbitrations between quantity and quality. When we have disaggregated data, its use is thus preferable with that of the usual methods. Nevertheless, it confirms that the use of the usual methods with unit values is an acceptable compromise when we do not dispose of sufficient information to build aggregate price indices.

ANNEXES

Table A.1: Detailed composition of the groups (to be continued)

Groups	Varieties	Observed purchases	mean prices francs / liter
Table wines	Non-returnable glass bottle of 0,75 cl	1873	11,81
	Plastic bottle	761	10,23
	Non-returnable glass bottle except 0,75cl	893	9,67
	Carton box	260	8,65
	Returnable glass bottle	620	8,04
	Cubitainer	353	7,41
Country wines	Country wines of area	875	16,27
	Country wines of region	1051	15,58
	Country wines of department	2154	10,58
Appellation wines	Burgundy regional appellation	482	32,81
	Burgundy "sub-regional" appellation	126	45,47
	Burgundy without great vintage in the village	115	55,49
	Burgundy with great vintage in the village or a large celebrity	84	84,32
	Beaujolais and Côtes du Rhône "primeur" wines	528	23,48
	Beaujolais, Mâconnais and Coteaux du Lyonnais regional appellation	675	25,40
	Beaujolais and Mâconnais with the name of the village	305	38,98
	Côtes du Rhône regional appellation	1803	18,56
	Côtes du Rhône without the name of the village	308	24,13
	Côtes du Rhône with the name of the village and vintages	298	41,63
	Alsace grapes authorized for great vintages	700	33,53
	Alsace grapes non-authorized for great vintages	604	24,45
	High quality dessert wines and yellow wines	127	81,13
	Other dessert wines	323	39,17
	Bordeaux AOC regional	2355	22,19
	Bordeaux AOC "sub- regional"	1080	30,95
	Bordeaux AOC without great vintage in the village	545	44,18
	Bordeaux AOC with great vintage in the village + Pomerol	167	68,54
	Wines of Languedoc Roussillon	1366	16,77
	Wines of Jura, Savoie and Bugey	221	36,98
	VDQS except Bugey	835	16,24
	Val de Loire AOC without the name of the village	1551	18,89
	Val de Loire AOC with the name of the village	511	34,55
	Wines of Provence	1151	20,40
	Wines of South-West	1502	21,77
	Wines of Spain	421	10,38
	Wines of Italy	173	18,29
	Wines of North-Africa	189	21,54
	Others foreign wines	161	25,15
Sparkling wines and ciders	Ciders and perries	2102	10,20
	Champagne	1572	99,27
	Sparkling wines with appellation	952	35,97
	Sparkling wines without appellation	1424	21,28

Table A.1: Detailed composition of the groups (to be continued)

Groups	Varieties	Observed purchases	mean prices francs / liter
Other alcoholic drinks	Blend Whisky	2448	97,76
	Blend Bourbon	447	76,60
	Whisky and bourbon straight	267	118,12
	Pure malt Whisky	424	140,23
	Whisky single	72	173,75
	Rum "agricole"	181	80,68
	Rum (white)	773	62,54
	Rum (brown)	44	53,34
	Cognac, Armagnac	407	113,61
	Grapes spirits	417	86,59
	Spirits like gin, vodka, tequila	422	79,36
	Punch	520	36,73
	Cocktails	526	28,17
	High quality orange liqueurs	81	136,48
	Other orange liqueurs	63	60,31
	Fruit liqueurs	556	79,58
	Other liqueurs	1115	43,15
	Liqueur wines like Muscat	1435	33,69
	Liqueur wines like Port	1854	48,37
	Wine-based liqueurs	1790	34,28
	Bitter liqueurs	499	51,48
	Gentian liqueur	641	43,07
	Pastis best known brands	1448	94,29
	Pastis without alcohol	141	20,65
	Pastis other brands	1990	71,72
Beer	Lambic	151	18,01
	Luxe	4237	7,52
	Bock	240	5,43
	Specialties	3377	12,99
	Exotic	247	21,26
	Shandy	1369	6,14
	Non alcoholic beer	470	8,47
Bottled water	Still mineral water	5397	2,08
	Sparkling mineral water	3843	4,03
	Still spring water	4964	0,90
	Carbonated spring water	966	2,06
Non carbonated soft drinks	Non carbonated flavored water	678	4,84
	Pure fruit juices refresh	811	12,68
	Pure fruit and vegetable juices preserved	4770	7,98
	Fruit juices made from concentrate	5424	5,76
	Nectar	4192	5,32
	Non carbonated fruit drinks	2895	4,37
	Non carbonated cold tea	1481	5,46
	Fruit syrup	4454	13,92
	Fruit squash	834	24,42

Table A.1: Detailed composition of the groups (end)

Groups	Varieties	Observed purchases	mean prices francs / liter
Carbonated soft drinks	Carbonated flavored water	672	6,53
	Carbonated fruit drinks	2378	7,12
	Soda	1555	3,92
	Lime	785	4,68
	Lemonade	1871	2,14
	Tonic	2199	6,65
	Cola	5557	4,51
	Energetic drink	93	20,27
	Carbonated cold tea	86	6,23

(Origin of the data: Sécodip, 1997, sub-sample of 2306 households.)

Table A.2 : Households and seasonal characteristics (class of reference in italic) (to be continued)

Variables	Size of the classes in %	Classes
Age of head of household	6,46	< 31 year old
	38,07	Between 31 and 44 year old
	55,46	*45 year old and more*
Higher education level in the household	15,83	Primary school
	41,72	Lower than bac (BEPC or equivalent)
	20,03	*BAC or equivalent*
	22,42	Higher than bac
Car possession	6,07	Without car
	53,38	*One care*
	40,55	More than one car
Profession of the head of household	2,12	Farmers
	3,69	Artisans
	5,68	Managerial staff
	15,44	Intermediate professions
	7,29	*Employees*
	3,12	Workers
	2,04	Retired farmers and artisans
	7,63	Retired managerial staff
	16,09	Retired workers or employees
	2,78	Without employment or profession

Table A.2 : Households and seasonal characteristics (class of reference in italic) (end)

Variables	Size of the classes in %	Classes	
Living region of the household	13,66	Parisian region	Parisian region
	12,62	North	North Picardie
	6,24	Normandy	Upper-Normandy Lower-Normandy
	12,27	West	Pays de la Loire Brittany
	11,41	Center	Center Poitou-Charentes Limousin Auvergne
	8,41	South-West	Aquitaine Midi-Pyrenees
	9,54	South-East (except Corsica, non-surveyed)	Languedoc Provence, Alps, Riviera
	12,58	*Middle-East*	*Burgundy* *Rhone-Alps*
	13,27	East	Champagne Lorraine Alsace Franche-Comté
Cellar	24,41	No cellar	
	75,59	*Cellar*	
Composition of the household	25,5	*Couple without children*	
	9,89	Household with one baby or more than one	
	17,91	Household with children between 3 and 16 year olds	
	6,11	Woman living alone	
	2,86	Men living alone	
	37,73	Other household	
Other storage place for spirits and liqueurs than kitchen, cellar or garage.	79,97	*No other storage place*	
	20,03	Other storage place	
Quarter of purchase	25,00	*Winter(30 December 1996 to 31 mars 1997)*	
	25,00	Spring (1 April 1997 to 30 June 1997)	
	25,00	Summer (1 July 1997 to 30 September 1997)	
	25,00	Autumn (1 October 1997 to 28 December 1997)	

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