EAAE Conference

Ghent, 26-29 august 2008

Are nutritional claims an adequate tool for public health ? Evidence from food purchases in France.[1]

France CAILLAVET, Véronique NICHELE, Louis-Georges SOLER[2]

Preliminary Draft

July 2008

Abstract

Nutritional claims have become a major instrument for providing consumers with information at the point of purchase, enabling them to make nutritionally appropriate choices. This paper deals with two public policy issues linked to the implementation of nutritional claims, i.e. efficiency and equity, in terms of nutritional outcomes and in terms of population targeting. We consider the French breakfast foods market at the household level using 2004 TNS Worldpanel data. We estimate a demand system taking into account the selection issue. For this we use the Shonkwiler and Yen's procedure which, unlike Heckman's, allows participation on every market of products to be controlled for. We propose a modification of this approach to address the methodological issue of satisfying the additivity constraint. This procedure is estimated on a set of dairy and cereal-based products which have different health attributes. Our results show that products with health claims play the role they are expected for. The light variants of dairy foods considered here appear to target households with members at health risk, obese or overweight. But interactions between products suggest some limits to efficiency on nutritional grounds. A higher probability of purchasing light products and with higher quantities coincides with higher purchases of biscuits and dairy desserts. Moreover, since lower income discourage the use of products with health claims, equity is not obtained and this should be stressed for policy implications.

Keywords: Nutritional claims, Food policy, Healthy diet, Censored Demand system

JEL: D12, D83

---

[1] This paper benefited from a DGAL funding. We thank A. Chaieb (ABIES) for good research assistance and C. Boizot-Szantai (ALISS) for the availability of data. Correspondence: France Caillavet - INRA, UR1303, ALISS - 65 Bd de Brandebourg – F-94205 Ivry-sur-Seine - Tel : 33.1.49.59.69.83 - Fax : 33.1.49.59.69.90 – Email: France.Caillavet@ivry.inra.fr

[2] Researchers at INRA UR1303, ALISS

I. INTRODUCTION

Increasing pathologies related to food, for example obesity, stress the need for public food policies. So far, researches have focused on price policies, in particular through the fat tax debate. Nevertheless, information policies may be an efficient tool. Nutritional claims have become a major instrument for providing consumers with information at the point of purchase, enabling them to make nutritionally appropriate choices. A study finds that consumers view food labels to be more credible than printed advertising (Mazis and Raymond 1997). Evidence of diet cacophony (conflicting messages, over-information, lack of nutritional knowledge) gives more weight to the necessity of regulating nutrition information by implementing official nutritional claims. Many studies have been made on the use of different forms of nutritional labelling directly on the package (signposting): traffic lights, GDA-based systems and energy labels (nutritional adequacy scores). Consumers declare they use nutrition labels, and main determinants have been identified as education, income, time, interest for health (Katouna et al. 2005, Drichoutis et al. 2006). More recently, European Commission harmonises the provisions laid down by law in Member States which relates to nutrition and health claims in order to ensure the effective functioning of the internal market whilst providing a high level of consumer protection (Regulation (EC) No 1924/2006). In order to ensure that the claims made are truthful, it is necessary that the substance that is the subject of the claim is present in the final product in quantities that are sufficient, or that the substance is absent or present in suitably reduced quantities, to produce the nutritional or physiological effect claimed. For instance, a claim stating that the content in one or more nutrients has been reduced may only be made where the reduction in content is at least 30 % compared to a similar product.

This paper deals with two public policy issues linked to the implementation of such nutritional claims, i.e. efficiency and equity, in terms of nutritional outcomes and in terms of population targeting. We raise several questions. As for the efficiency issue: who are the consumers of the healthier variants of products and are nutritional claims useful for the population at health risk? Do nutritional claims contribute to a better diet? To answer these questions, we need to measure the interactions between less healthy and healthier foods. Some papers argue that the consumption of less nutritious foods may induce compensation through increased consumption or substitutions with less healthy choices on other food products. This would be a serious drawback of a nutritional claim policy. As for the equity issue, we question the impact of economic constraints on the use of products with nutritional claims. Considering these issues require demand modelling. We are interested to know the determinants of the choice of healthy variants and the interactions between goods that are induced by this choice. The estimation of demand elasticities may be useful to know the impact of price, and in particular of relative prices of less healthy and healthier choice. Since consumers do not buy each category of products, we face a strong selection issue when estimating a demand system. We use here a two-step procedure that we had to adapt to the usual AIDS specification. In this paper we obtain estimates of

own and crossed price elasticities of demand for the major categories of breakfast foods including the variants with nutritional claims. Our results support the specific role devoted to products with health claim in the breakfast foods market and allow to consider various informational policies.

Food for breakfast and nutritional claims

Health and nutritional claims concern mainly sugar, fats, or salt contents. Note that in 2004, year of our data, the health claims present on the French market concern light variants and not enriched ones. In France, as in other developed countries, consumers coincide on the 2 major nutrition issues: fats and sugar (ACNielsen 2005). We examine the choice consumers face at a coherent moment of consumption, such as breakfast. The relevant set of foods strongly associated to each meal occasion has been studied by Hebel (2007). According to this study, the main foods consumed are drinks, dairy products and cereals. The drinks set covers mainly hot drinks such as tea or coffee, or cold drinks such as water, soft drinks and juices. For the sake of homogeneity of comparison between products, we will exclude drinks and deal here with the solid foods of the breakfast set. In this framework, dairy products include yogurts, dairy desserts, fresh cheese, milk; cereals-based products include breakfast cereals, bread, rolls, pastries, biscuits. Competing products may be quite different on nutritional grounds. To capture this nutritional differentiation, we introduce two variants for some products: the less healthy one (standard) and the healthier one (light) with a health claim. In 2004, the health claims present on products for breakfast define healthier variants through fat contents (yogurts, fresh cheese, dairy desserts). The light variant represents between 5.1% (dairy desserts) to 35.3% (yoghurts) of the annual quantities purchased of a product. Note that the pricing strategy of firms may differ: the price of the light variant may be lower than the standard product. But most of the times, the version with health claim has a higher price. This position is influenced as well by the label type (distributor or producer). Consequently, the variant with health claim is neither nutritional nor price equivalent. This introduces the equity dimension of a regulatory policy, especially relevant when populations more at risk are over-represented in lower income households.

II- DEMAND MODEL

A demand system taking into account the selection issue

Cragg (1971) with double-hurdle models and Heckman (1979) with selection bias control made substantial contributions to the modelling and estimation of censored equations. Heckman procedure was based on regression type estimators only on strictly positive observations. However, each dependent variable in a demand system may have a different pattern of censoring. Taking into account the different censorship induced by the selection on each component of the system may be quite cumbersome. For this reason, Heien & Wessells (1990) proposed a two-step estimation procedure for a demand system of equations based on the whole sample (thus keeping both censored and uncensored households). Each equation is augmented by a selectivity regressor derived from the

probit estimates obtained in the earlier step. However, Shonkwiler & Yen (1999) have revealed an internal inconsistency in this estimation procedure. They proposed an alternative two-step procedure based on all the observations. However, in the framework of demand system, with shares summing up to 1, it is quite difficult to handle all the constraints induced by the model and in particular the additivity constraints. Some papers addressed this issue by *ad hoc* solutions. Yen, Kan and Su (2002) dropped the additivity restriction. Yen, Lin and Smallwood (2003) and Dong, Gould and Kaiser (2004) dropped an equation and impose *ex post* the additivity. Within the Shonkwiler and Yen framework, we proposed an iterated procedure to solve the additivity problem (Caillavet 2005). Here we improve this model and take into account the endogeneity of expenditure[3]. In the following, breakfast foods consumption is modelled in two steps.

The first step deals with participation to the market and models the decision of household *h* to consume product *i*:

$$(1)\qquad \begin{aligned} d_{ih}^{*} &= Z_h'\alpha_i + \upsilon_{ih} \\ d_{ih} &= \begin{cases} 1 & if \quad d_{ih}^{*} > 0 \\ 0 & if \quad d_{ih}^{*} \le 0 \end{cases} \end{aligned}$$

for $i=1,\ldots n$ and $h=1,\ldots H$.

The observed variable is d_{ih}, the decision to consume breakfast foods (1 for potential consumers, 0 for non-consumers) : it is related to the latent variable d_{ih}^{*}, which may be interpreted as an utility index.

Z' is a vector of exogenous variables, such as household and environmental characteristics.

The second step deals with the amount consumed and is modelled using an Almost Ideal Demand System (AIDS), see Deaton and Muellbauer (1980), that is:

$$w_{ih}^{*} = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \log p_{jh} + \mu_i \log\left(\frac{x_h}{P_h}\right) + \varepsilon_{ih},$$

where w_{ih}^{*} is the budgetary share allocated to the i product by the household *h*, p_{jh} is the price of a food category *j* for the household *h*, x_h is the total food expenditure of the household *h*, P_h is the price index and α_i, γ_{ij} and μ_i are the parameters to estimate. For simplicity, we will denote X' the vector of the exogenous variables that is

$$X_h' = \left(1, (\log p_{jh})_{1\le j\le n}, \log\left(\frac{x_h}{P_h}\right)\right) \text{ and } \beta_i = (\alpha_i, (\gamma_{ij})_{1\le j\le n}, \mu_i).$$

Here again the observed variable is w_{ih} related to the latent variable w_{ih}^{*} by the following equations

$$(2)\qquad w_{ih}^{*} = X_h'\beta_i + \varepsilon_{ih} \qquad and \qquad w_{ih} = d_{ih} w_{ih}^{*}$$

[3] For this, we instrument log(expenditure) with log(income).

We assume that ε_{ih} and υ_{ih} are residuals such that $(\varepsilon_{ih}, \upsilon_{ih})$ follows a bivariate normal distribution with $Var(\varepsilon_{ih}) = \sigma_i$, $Var(\upsilon_{ih}) = 1$ *and* $Cov(\varepsilon_{ih}, \upsilon_{ih}) = \delta_i$. In the following Φ and φ are respectively the cumulative distribution function and the density of the standard gaussian random variable. Then, the system of equation (1) may be rewritten as in Shonkwiler & Yen (1999) as

$$(3) \qquad \begin{aligned} & w_{ih} = \Phi(Z_h'\alpha_i)\ X_h'\beta_i + \delta_i \varphi(Z_h'\alpha_i) + \xi_{ih} \\ & where \quad \xi_{ih} = w_{ih} - E\left(w_{ih} \middle| X_h, Z_h\right) \end{aligned}$$

is such that $E\left(\xi_{ih} \middle| X_h, Z_h\right) = 0$.

We refer the reader to Shonkwiler and Yen (1999) for further technical details and to Tauchmann (2005) for alternative estimation procedures. The elasticities are obtained by differentiating equations (3). They take the following form:

$$(4) \qquad e_i = 1 + \frac{\mu_i}{w_i}\Phi(Z_h'\alpha_i) \text{ for expenditure elasticities}$$

$$(5) \qquad e_{ij} = \frac{\Phi(Z_h'\alpha_i)}{w_i}(\gamma_{ij} - \mu_i w_j) - \delta_{ij} \text{ for price elasticities.}$$

Application to a demand system

The Shonkwiler & Yen's methodology raises several difficulties when applied to demand systems. Several problems remain unsolved when taking into account the restrictions induced by the microeconomic theory of demand. In our AIDS framework, the additivity restriction cannot be integrated in the Shonkwiler & Yen's method. This restriction states that: $\forall\, h \qquad \sum_{i=1}^{n} w_{ih} = 1$. Yen himself, when using his own model to estimate a demand system (Yen, Kan & Su, 2002) chooses to relax this restriction (notice that he does not take either the heteroscedasticity of the residuals into account).

In order to estimate our model under the additivity constraint, we propose to decompose the demand system estimation in the three following steps :

- 1st step: we estimate the model on the censored sample, equations by equations: $w_{ih} = X_h'\beta_i + \lambda_i \frac{\varphi\left(Z_h'\hat{\alpha}_i\right)}{\Phi\left(Z_h'\hat{\alpha}_i\right)} + \eta_{ih}$, h=1,…H, so as to obtain the least square estimator $\tilde{\beta}_i$ of β_i. Any other convergent estimator (for instance FGLS estimator) may be used at this step.

- 2nd step: If we add all the shares in equation (3) we get that $1-\sum_{i=1}^{n}\Phi(Z'_h\alpha_i)\,X'_h\beta_i=\sum_{i=1}^{n}\delta_i\varphi(Z'_h\alpha_i)+\sum_{i=1}^{n}\xi_{ih}$, h=1,…,H. Since estimators of α_i ,β_i are available, this suggests to estimate δ_i by regressing

$1-\sum_{i=1}^{n}\Phi(Z'_h\hat{\alpha}_i)\,X'_h\widetilde{\beta}_i$ on all the $\varphi(Z'_h\hat{\alpha}_i)$'s for *h*=1,…H. The resulting $\hat{\delta}_i$ are convergent estimators and satisfy the additivity constraint.

- 3rd step: we re-estimate the parameter β_i by FGLS estimators in the demand system by considering the regression :

$\frac{w_{ih}-\hat{\delta}_i\varphi(Z'_h\hat{\alpha}_i)}{\Phi(Z'_h\,\hat{\alpha}_i)}=X'_h\beta_i+\upsilon_{ih}$ and imposing the homogeneity and the symmetry restrictions of the standard AIDS.

We then iterate steps 2 and 3 until convergence of the estimated parameters. At the final step we get convergent estimators, which satisfy all the constraints (additivity, symmetry and homogeneity).

III- DATA AND METHODS

3.1. Data

We use data from the 2004 issue of the TNS Worldpanel French consumption panel. This data set registers daily food purchases, and provides information on quantities and expenditures.[4] Households are requested to register their food purchases for at-home consumption on the basis of daily purchases through the use of a scanner. TNS data have a specific structure: households are assigned to 2 subsamples, and are requested to register their purchases of a restricted set of fresh food products. Hence the list of products covered by each subsample differs, although there is some overlap. This means that we have no complete information on food purchases for a given household. For this reason, we have to postulate the weak separability of preferences between breakfast foods and other food groups in the household budget. Though a clear limitation of our data, the TNS Worldpanel survey remains the only current data source allowing the computation of disaggregated unit values for food, by registering quantities and expenditures for detailed food products, and in particular mentioning health claims. Health and nutritional claims belong to the description of the product

[4] Data on home production and away-from-home consumption are not registered by TNS.

registered by a variable coded by TNS. In this study a product will be considered "light" if it is registered as "reduced in fat", or "without added fat", or "low-fat".

As purchases are registered throughout the whole year, we can consider that the real consumption corresponds to the purchases observed. This means that, when a household has zero purchases, we consider that the good is not in the preferences set. In order to deal with products interactions, we distinguish in the breakfast set 9 groups which have different health attributes. Among dairy products, we distinguish 5 categories: milk, plain yogurts (including uncured cheese and petit-suisse), flavoured yogurts (including uncured cheese and petit-suisse), other dairy desserts, light variants (of flavoured yogurts and other dairy desserts); among cereal-based products, 4 categories: breakfast cereals, bread, biscuits, pastries and rolls. Our sample counts 4651 households.

3.2. Variables

The dependent variables

For the nine groups specified above, the model estimates in the first step, the probability of participation to the market of each product, as a dichotomous variable. In the second step, the nine budget shares of the groups in total breakfast foods expenditure.

The independent variables

Prices are not available in our survey. The use of unit values as prices is known to neglect differences in quality. An approach was developed by Deaton (1988) based on clustering. Alternative methods capture the quality effect through the estimation of a hedonic equation (Cox and Wohlgenant 1986, Gao, Wales and Cramer 1995). In this paper, we use this latter method to calculate quality-adjusted prices[5]. The quality price adjustment is particularly important when the commodities under study have large quality and price variations. In the case of this study, the effect of quality maybe limited for some elementary goods such as milk or plain yogurts, but is certainly relevant in the case of composite products such as bread or biscuits.

Sociodemographic influences are controlled through the introduction of the characteristics (age, education) of the person in charge of purchases in the household (most of the time the wife). Several variables capture the impact of the household composition by introducing the proportion of members according to their age category. Regional effects are captured through 8 dummies, and size of the residence area through 1 dummy. Economic constraints are expressed with household income including all sources of income and expressed per unit of consumption using Oxford/OCDE

[5] They are defined as the difference between the unit value and the expected price, given its specific quality characteristics. The expected price is calculated by a hedonic price function $\Pi_{ih} = \lambda_i + \sum_i \eta_i Y_{ijh} + e_{ih}$ where Y_{ijh} are variables affecting the consumer's choice of qualities such as income and household characteristics as proxies for preferences for unobservable quality characteristics. The quality adjusted price is then defined by $\Pi^*_{ih} = \Pi_{ih} - \sum_j \hat{\eta} Y_{ijh}$. For missing observations, prices were predicted by estimating observed prices for purchasing households on characteristics variables.

scale. Of special interest is the BMI of the members of the households as a proxy for identifying the population at health risk. TNS registers the size and the weight of all members. We built two measures, one based on the panelist's BMI, and one based on the higher BMI observed among the other members, on the assumption that household purchases may reflect differently degree of concern for health status. The description of the sample may be found in table 1.

IV. RESULTS

4.1. Mean purchases

Households with overweight or obese members purchase significant higher mean quantities per capita of milk, dairy desserts, light variants, biscuits, and lower quantities of plain yogurts, bread and breakfast cereals[6]. At the same time, those households purchase at lower mean unit values. This can be seen for every product of the breakfast set. Unit values are known to embody a quality effect. Then a crucial issue would be to evaluate the nutritional consequences, if any, of a purchasing strategy based on lower quality products. A study on the nutritional content of lower price food based on front of pack information is not conclusive in the French case (Darmon *et al*. 2008). Lower income households dedicate a higher budgetary share to milk and most cereal-based products[7]. This is consistent with previous budget analysis based on INSEE data (Andrieu *et al*. 2006). It shows also that light variants and bread represent a bigger weight for higher-income households.

4.2. The probability of purchasing breakfast foods (table 2)

Age of the panelist increase the probability of purchasing, with a typical Inverse U shape for most products. Younger members have a positive effect on both dairy and cereal products, while adult members or a male panelist have a negative impact. Overweight or obese panelist favour the purchases of light and flavoured yogurts and discourage biscuits purchases. Concerning the association of education with nutritional knowledge, the positive impact of a lower educational level on the purchases of dairy desserts enters this framework, but the negative impact of a higher level on the probability of purchasing the light variants is quite unexpected. For example, Kim and Douthitt (2004) find that highly educated women are less likely to consume whole milk. An urban environment has a positive influence on the products which are the more supported by food marketing: among cereal based products: breakfast cereals and among dairy products: flavoured yogurts, dairy desserts, light variants. This latter result is also found by Kim and Douthitt (2004) and Robb et al. (2007) on low-fat milk. Note that, the probability of purchasing light variants is sensitive to the whole set of sociodemographic variables used here, conversely to other food categories, and in particular education and BMI.

4.3. The share of foods in the breakfast set

Expenditure and income elasticities (table 3)

[6] Test of means, results available upon request.
[7] Idem.

All elasticities are significant, mostly at the 1% level. Expenditure elasticities are higher for breakfast cereals and milk. Including the light variants of dairies, these products are characterized as superior goods. Conversely, most cereal-based products and dairy desserts appear to be inferior goods. In this framework, an increase of 1% of the budget dedicated to the breakfast set induces an increase of the quantities purchased of 1.4% for breakfast cereals and milk, 1.2% for flavoured yogurts and light variants, and only 0.6% for biscuits and 0.4% for dairy desserts.

Price elasticities (table 3)

Direct price elasticities show a higher sensitivity, among dairy products, of light variants and flavoured yogurts, and among cereal-based products, of rolls and pastries and breakfast cereals. With a 1% price increase, the purchases of these products decrease respectively of 1.6%, 1.5% and 1.1%. For the same price variation, milk purchases decrease by only 0.8%. Many crossed price elasticities are significant, which corroborates the relevance of the breakfast set identified by the Hebel study and applied here, and sheds light on interactions between products. Note that substitution relationships are predominant. We observe that dairy products and cereal-based products relate more strongly within they own category than with the other. Plain and flavoured yogurts, as well as dairy desserts and the light variants are all substitutes. Any price increase induces a reallocation of purchases: in particular an increase in the price of light variants induces an increase of dairy desserts. We observe an isolated and weak complementarity between breakfast cereals and plain yogurts.

Sociodemographic effects (table 4)

Purchases of most products reflect the impact of presence of young members in the household: positive for dairy desserts, breakfast cereals and biscuits, negative for all kinds of yogurts and light variants. A male panelist is associated with a higher share of cereal-based products, dairy desserts, flavoured yogurts and milk. As for the impact of education, the budgetary share of plain yogurts and cereals increases with a higher level, but the rolls and pastries as well as the biscuits ones decrease. This appears to be an association with healthier choices. The impact of BMI varies according to the products considered. An obese or overweight panelist, as well as other members, influence negatively the shares of plain yogurts, and breakfast cereals. In the case of the others members, overweight induces also a higher budgetary share dedicated to dairy desserts. Note that geographic and spatial variables determine purchases, except for light variants.

In conclusion, the purchases of light variants are very sensitive to price variations and moderately to budget variations. They substitute with other dairy products, suggesting a very flexible demand. This result induces possibilities of intervention on demand, in so far as the price difference with the standard variant is not too high. Remember that households with obese members purchase at a lower unit value, whatever the product considered. Nevertheless, our results focus on a breakfast set which cannot represent the whole set of food products found in a diet. In this framework, we cannot answer to the compensation hypothesis, which would relate an increasing consumption of light products with an increasing consumption of less healthy foods (nutritional or psychological effect).

But we observe interesting characteristics of the consumption behaviour of households with members at health risk (obese or overweight). From one side, they have a higher probability of purchasing light products and with greater quantities. At the same time, the same households purchase higher quantities of biscuits and they dedicate a higher budget share to dairy desserts.

V. CONCLUSIONS AND POLICY PERSPECTIVES

In the framework we described above, products with health claims play the role they are expected for. The light variants of dairy products in the breakfast set target households with members at health risk (obese and overweight) and adults more than children (negative effect of the latter).

The elasticities show that light variants purchases are highly sensitive to price, and to a lesser extent to budget variations. If households have a good response to economic incentives, some policy interventions are relevant, in so far that the price lag between standard and light variants keeps moderate. In effect, a price increase of light products re-affects consumption towards less healthy choices. Such a conclusion leads to raise an important issue. The European Regulation imposed that a claim stating that the content in one or more nutrients has been reduced may only be made where the reduction in content is at least 30 % compared to a similar product. This constraint leads often to a large price differentiation between the standard and the light products. It is likely that a weaker constraint would lead to a smaller price differentiation. Given the price elasticity of the light variants, this would lead to a larger consumption of light products. In this case, the positive effect linked to a lower consumption of fat or sugar could be greater for the whole population. This is an issue which must be analyzed in further research.

The coexistence of positive impacts on light variants and the more nutritive dessert foods for the same consumers is consistent with a nutritional compensation hypothesis. But for definite conclusions, the whole diet has to be taken into account. Nevertheless, interactions in a limited set of products like the breakfast set we considered here is quite informative. In this framework, nutritional claims appeared to be efficient in targeting population at risk. Since a negative effect of income is obtained on the probability of purchasing light variants, equity is not obtained and this should be stressed for further policy implications.

References

AC Nielsen. 2005. Fat content of most concern to US consumers when shopping for food, according to ACNielsen. http://us.nielsen.com/news/20050727.shtml

Andrieu E., Caillavet F., Momic M., Lhuissier A., Régnier F. 2006. L'alimentation comme dimension spécifique de la pauvreté. *Les Travaux de l'ONPES 2005-2006*, p.247-278, Paris, La documentation française.

Caillavet F. 2005. Poverty and fat consumption: education poor or income poor? *Food Economics* 2(3-4), p.191-204.

Caillavet F., Chaieb A., Nichèle V., Soler L.G. 2008. Allégations, différenciation nutritionnelle des aliments et comportements d'achat des ménages. Rapport DGAL.

Cox T.L., Wohlgenant M.K. 1986. Price and quality effects in cross-sectional demand analysis. *American Journal of Agricultural Economics* 68:908-919.

Darmon N., Caillavet F., Joly C., Maillot M., Drewnowski A. 2008. Low-cost foods: how do they compare with their brand name equivalents? A French study. *Public Heath Nutrition*

Deaton A.S. 1988. Quality, quantity and spatial variation of price. *American Economic Review* 78: 418-430.

Dong, D., Gould B.W., Kaiser H.M. 2004: Food demand in Mexico: an application of the Amemiya-Tobin approach to the estimation of a censored food system.

Drichoutis A.C., Lazaridis P., Nayga R.M. 2006. Consumers' use of nutritional labels: a review of research studies and issues. *Acad. Marketing Sc. Review* n° 9. *http://www.amsreview.org/articles/drichoutis09-2006.pdf*

Gao X.M., Wailes E.J. and Cramer G.L. 1995. Double-hurdle model with bivariate normal errors: an application to U.S. rice demand. *Journal of Agricultural and Applied Economics* 27:363-376.

Hebel P.(coord.) 2007. Comportements et consommations alimentaires en France. Paris, Editions Lavoisier.

Heckman, J. 1979. Sample Selection bias as a specification error. *Econometrica* 47, 153-163.

Heien, D. & Wessells, C. 1990. Demand system estimation with micro-data: A censored regression approach. *Journal of Business & Economics Statistics* 8, 365-371.

Kim S., Douthitt A. 2004. The role of dietary information in women's whole milk and low-fat milk intakes. *International Journal of Consumer Studies* 28: 245-254.

Lin C.T.J., Lee JY, Yen ST. 2004) Do dietary intakes affect search for nutrient information on food labels? *Social Sciences and Medicine* 59:1955–1967.

Mazis M., Raymond M. 1997. Consumer perceptions of health claims in advertisements and on food labels. *Journal of Consumer Affairs* 31:10-27.

Robb C.A., Reynolds L.M., Abdel-Ghany M. 2007. Consumer preference among fluid moilks: low-fat vs. high-fat milk consumption in the United States. *International Journal of Consumer Studies* 31:90-94.

Schonkwiler, J. S. & Yen, S. 1999. Two-Step estimation of a censored system of equations. *American Journal of Agricultural Economics* 81, 972-982.

Steward-Knox B., Hamilton J., Parr H., Bunting B. 2005. Dietary strategies and uptake of reduced fat food. *Journal of Human Nutrition and Dietetics* 18: 121-128.

Tauchmann, H. 2005. Efficiency of two-step estimators for censored systems of equations: Shonkwiler and Yen reconsidered. *Applied Economics* 37, 367-374.

Yen, S., Kan, K. and Su, S-J. 2002. Household demand for fats and oils. *Applied Economics* 34, 1799-1806.

Yen S.T., Lin B.H., and Smallwood D. 2003. Quasi-and simulated-likelihood approaches to censored demand systems: food consumption by food stamp recipients in the United States. *American Journal of Agricultural Economics* 85:458-478.

Table 1 : Description of the sample
N= 4651

variable	Mean	Standard-error	Min	Max
Age	50.50	14.98	20.00	97.00
Family composition				
p0_13years (%)	0.12	0.20	0	0.75
p14_24 years (%)	0.11	0.19	0	1
p25_39 years (%)	0.18	0.30	0	1
p40_65 years (%)	0.38	0.38	0	1
p65 years (%)	0.21	0.39	0	1
Residence area				
Rural area	0.48	0.50	0	1
Urban area	0.52	0.50	0	1
Educational level				
<bac	0.58	0.49	0	1
bac level	0.18	0.39	0	1
>bac	0.23	0.42	0	1
Family income/UC (€)	1333.26	686.03	166.67	6199.50
BMI				
slim and normal	0.34	0.48	0	1
overweight	0.39	0.49	0	1
obesity	0.17	0.37	0	1
undeclared	0.10	0.30	0	1

Source : TNS Worldpanel 2004

Table 2 : Probability of purchasing breakfast foods (probit model)

	Milk	Plain yogurts	Light variants	Flavoured yogurts	Dairy Dessert	Bread	Breakfast Cereals	Rolls and pastries	Biscuits
Age	0.021	0.051**	0.027*	0.026	0.026	0.002	0.064***	0.005	0.006
Age^2	-0.0002	-0.0004*	-0.0004**	-0.0003**	-0.0004**	-0.0001	-0.0007***	-0.0002	-0.0001
Male	-0.701***	-0.803***	-0.591***	-0.529***	-0.476***	-0.829***	-0.619***	-0.473***	-0.949***
p0_13	0.199	0.761**	0.553***	1.773***	1.293***	0.349	1.579***	1.973***	0.793
p14_24	-0.445	0.292	0.247	0.674***	0.487**	0.598***	1.446***	0.845**	0.662
p25_39	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
p40_65	-0.540*	-0.391**	-0.082	-0.334**	-0.492**	-0.359	0.599***	-0.138	-0.288
p65	-0.525	-0.289	-0.173	-0.538**	-0.458**	-0.230	-0.538***	-0.183	-0.271
Education < Bac	0.056	-0.147	0.039	0.041	0.210**	0.166	-0.163**	0.097	-0.067
Bac level	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
> Bac	0.166	0.076	-0.117*	-0.142*	0.044	0.179	-0.056	-0.120	-0.142
Panelist BMI *normal*	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
overweight	0.157	0.031	0.019	0.148*	0.149	0.202	0.041	0.152	-0.553**
obesity	0.180	0.026	0.241***	-0.049	0.094	0.131	-0.030	0.012	0.008
nd	0.139	-0.096	0.061	0.048	0.120	0.169	0.062	0.371***	-0.031
Other members BMI *normal*	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
overweight	-0.168	-0.136	0.047	-0.040	-0.027	-0.092	-0.072	0.075	0.259
obesity	0.010	0.188	0.110	0.030	0.040	-0.085	-0.087	-0.049	-0.416
nd	-0.482***	-0.298**	-0.076	-0.078	-0.137	-0.171	-0.126*	-0.327***	-0.639***
Urban area	0.075	0.053	0.148***	0.101*	0.134***	-0.071	0.119**	-0.018	-0.109
Parisian Region	-0.170	-0.228	0.079	-0.002	0.012	0.125	-0.144*	0.126	-0.057
East	0.100	-0.215	0.219	0.145	-0.047	0.026	0.022	0.089	0.323
North	0.229	-0.311**	0.346***	0.188*	0.225*	0.024	-0.206**	0.324**	0.198
West	-0.004	-0.291**	0.134**	0.043	0.150	-0.328**	-0.093	0.193	0.294
Center-West	0.101	0.265	0.127	-0.100	0.061	-0.235	-0.064	0.096	0.300
Center-East	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
South-East	-0.099	-0.117	0.188**	0.033	0.063	0.712***	0.081	0.230*	0.066
South-West	-0.151	-0.354**	0.104	-0.032	0.134	-0.215	-0.130	0.174	0.087

*, **, *** : significativity at 10%, 5%, 1%

Table 3 : Compensated price elasticities, expenditure and income elasticities at the mean point

	Milk	Plain yogurts	Light variants	Flavoured yogurts	Dairy Dessert	Bread	Breakfast Cereals	Rolls and pastries	Biscuits	Expenditure elasticity	Income elasticity
Milk	-0.833***	0.165***	0.080***	0.150***	0.092***	0.086***	-0.024	0.193***	0.091***	1.407***	0.306***
Plain yogurts	0.212***	-1.150***	0.152***	0.240***	0.210***	0.069***	-0.095***	0.187***	0.174***	1.106***	0.240***
Light variants	0.199***	0.275***	-1.610***	0.075	0.344***	0.183***	0.129**	0.268***	0.136**	1.183***	0.257***
Flavoured yogurts	0.302***	0.372***	0.062	-1.471***	0.140***	0.119***	0.110***	0.098**	0.268***	1.227***	0.267***
Dairy Dessert	0.153***	0.264***	0.244***	0.110***	-0.883***	0.002	0.072**	0.032	0.006	0.401***	0.087***
Bread	0.197***	0.123***	0.184***	0.134***	-0.003	-0.829***	0.045	-0.009	0.158***	0.828***	0.180***
Breakfast Cereals	-0.020	-0.153***	0.149**	0.148***	0.127**	0.063	-1.030***	0.361***	0.355***	1.409***	0.306***
Rolls and pastries	0.252***	0.191***	0.151***	0.059**	0.023	-0.004	0.182***	-1.059***	0.205***	1.069***	0.232***
Biscuits	0.100***	0.149***	0.057**	0.147***	-0.003	0.076***	0.150***	0.172***	-0.848***	0.596***	0.130***

*, **, *** : significativity at 10%, 5%, 1%

Table 4: Impact of sociodemographic variables on the budget shares of breakfast foods

	Milk	Plain yogurts	Light variants	Flavoured yogurts	Dairy Dessert	Bread	Breakfast Cereals	Rolls and pastries	Biscuits
Age	-0.005***	0.002	-0.0001	-0.002	-0.0001	-0.003***	-.0.004***	-0.002	0.002*
Age^2	0.0001***	0.0000	0.0000	0.0000	0.0000	0.0000***	0.0000***	0.0000	-0.0000*
Male	0.095***	0.0000	-0.003	0.032***	0.018*	0.035***	0.027***	0.050***	0.022**
p0_13	-0.011	-0.072***	-0.111***	-0.002	0.055***	-0.031**	-0.008	0.011	0.136***
p14_24	-0.022	-0.085***	-0.076***	-0.042***	0.031**	-0.011	0.048***	0.013	0.108***
p25_39	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
p40_65	0.030**	0.028**	0.021*	0.008	0.011	0.002	0.016*	-0.014	0.003
p65	0.018	0.056***	0.015	-0.011	-0.010	-0.003	0.011	-0.019	0.023*
< Bac	0.013**	-0.017***	0.003	0.005	-0.003	-0.004	-0.003	0.004	-0.005
Bac level	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
> Bac	0.002	0.012**	0.006	0.004	-0.008	0.004	0.012***	-0.017***	-0.011**
Panelist BMI normal	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
overweight	-0.008	-0.005	0.005	0.005	-0.003	-0.005*	-0.007*	-0.002	0.007
obesity	0.010	-0.022***	0.009	-0.008	-0.001	-0.005	-0.005	-0.003	-0.0008
nd	-0.014	-0.020**	-0.013*	0.003	0.014*	-0.008*	-0.018***	0.0004	0.011
Other members BMI normal	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
overweight	-0.0001	-0.011**	0.002	-0.0001	0.014***	0.005	-0.007*	0.002	0.0005
obesity	-0.007	-0.006	0.008	-0.0004	0.007	0.006	-0.007	-0.0004	0.006
nd	0.037***	0.010	0.021**	0.006	-0.021**	0.009*	0.021***	-0.011*	-0.013*
Urban	-0.021***	0.005	0.006	0.013**	0.003	0.005**	-0.003	0.020***	-0.006
Parisian Region	-0.009	-0.014*	0.006	0.014**	0.002	0.010**	0.0003	0.002	-0.004
East	0.007	-0.037***	0.010	0.014**	0.006	-0.007	-0.004	-0.0004	0.002
North	0.004	-0.037***	0.008	0.012*	0.014	-0.011**	-0.002	-0.011*	0.007
West	0.0009	-0.030***	0.010	0.006	0.015**	0.002	-0.005	0.020***	-0.020***
Center-East	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Center-West	0.0005	-0.015*	-0.002	-0.003	0.013*	0.009	-0.005	0.009	-0.014**
South-East	-0.005	-0.022***	0.005	-0.005	0.006	0.012**	-0.0005	0.010	-0.015**
South-West	0.0006	-0.013	0.006	0.010	0.007	0.010**	-0.002	-0.004	-0.008

*, **, *** : significativity at 10%, 5%, 1%