# The XVIIIth Annual EAFE Conference

## THE CHANGING PATTERN OF HOUSEHOLD DEMAND FOR SEAFOOD AND OTHER ANIMAL PRODUCTS IN SPAIN

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**ABSTRACT**

This paper continues the analysis by Millán and Aldaz (IIFET2006) in which only seafood demand is analysed. In this paper, censored demand systems of household seafood and other products of animal origin are estimated with a two step procedure, using cross-section data from Surveys of Consumption Expenditure in Spain for 1981, 1991 and 1998. There is evidence of non decreasing food expenditure elasticity for seafood and very important changes in complementarity and substitution patterns.

**Keywords:** Seafood demand, animal consumption, censored demand systems, Spain.

We acknowledge funding from Project ALG04-7303 of the National Plan for Research of the Spanish Government.

30th August 2007

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## INTRODUCTION

Many factors influence seafood consumption: income, prices, general economic conditions and socio-economic variables. Millán (2002) summarizes the main characteristics of the Spanish seafood consumption in 1998 and its evolution over the previous decade. In the 1980s and 1990s, there was decreasing consumption of seafood products, although not at a regular pace: at the end of the 1980s and in the mid-1990s there was a remarkable decline, while at the start of the 1990s, consumption rose. A relevant fact about the evolution of seafood consumption in Spain is that there is no clear trend in the different components of consumption (Millán, 2002:288).

In Millán and Aldaz (2006) seafood demand is analysed using censored demand equations for only one item. It is found that fundamental economic variables are more interesting that socio-economic change. In particular, there is taste change in the 80s, increasing price elasticity and becoming seafood animal food complement. Non decreasing food expenditure elasticity is found too. Given that complementarity between seafood and other animal products is not an expected result, Millán and Aldaz (2006) suggest a joint analysis, using censored demand system, of seafood, meat and eggs and dairy consumptions.

The structure of the paper is as follows. In the next section, the data are introduced and discussed. It follows a short presentation of the specification and estimation issues of the model. The empirical analysis and the discussion of the results are presented in the following section. Finally, a summary of results and some implications of the research conclude the paper.

## DATA

The data we use for the estimation of the demand system is microdata belonging to the Surveys of Consumption Expenditure 1980/81 (hereafter ‘1980’) and 1990/91 (hereafter

'1990') and the longitudinal data for 1998 ('1998') of the Household Budget Continuous Survey, organized by the Spanish Statistical Office INE.

The data from the 1980 and 1990 surveys have been used in the collection prepared by Arévalo et al. (1998) and Alonso-Colmenares *et al*. (1999) at the University Carlos III of Madrid. They are available at the Internet (www.eco.uc3m.es/investigacion). We have used the files with household characteristics and the consumption by headings. There are 24 food and drink categories, with two for seafood products, five for meat products and three for eggs, milk and dairy products.

For the 1998 data, we have used the goods files of the Households Budget Continuous Survey. We aggregate the expenditures in the 24 food headings and have not used the quantity data for food products. Household information comparable to those available in 1980 and 1990 is selected from the household files. These data (and those of the following surveys) have become available for free via the Internet (www.ine.es). The Households Budget Continuous Survey, started by INE in the third quarter of 1997 in the current form, provides information on the nature and purpose of consumption expenditures, as well as on diverse characteristics respecting the way of life of households. The data that requires the use of the longitudinal file have a flexible year for the household information reference year. Hence the longitudinal data 1998 uses purchases from the third quarter to 1997 to the second quarter of 1999. Food items have been aggregated in the 24 food headings of the Surveys of Consumption Expenditure (and the Spanish Consumption Price Index).

The dependent variables in the analysis are the participations in consumption, taking the form of a binary variable, and the shares in food expenditure of seafood, meat, eggs and dairy products, and other food. The demographic variables used in this analysis are listed and described in Table 1. Some interesting variables in the literature (such as a working female) are not used because of accessibility difficulties or lack of comparability between 1980, 1990 and 1998. We have aggregated the Autonomous Communities of Spain into four regional variables.

The proportion of households buying seafood is high, in general. The exception is the one-adult household, with or without children, with participation around 70%. One-

adult households are excluded from the analysis. Sample size is 21756 households in 1980 (91% of households), 18747 in 1990 (88.9%) and 8771 in 1998 (89%).

**Table 1: Demographic Variables**

| *Variable* | *Description* |
|---|---|
| LAGE | Logarithm of the age of head of household |
| SEX | 1= Female head of household ; 0= male head of household |
| PERSONS | number of household members |
| habitat1 | 1= Density: Sparsely populated area; 0= otherwise (reference in equations) |
| HABITAT2 | 1= Density: Intermediate area; 0= otherwise |
| HABITAT3 | 1= Density: Highly populated area; 0=otherwise |
| study1 | 1= No education or primary education; 0= otherwise (reference in equations) |
| STUDY2 | 1= Secondary education; 0= otherwise |
| STUDY3 | 1= Higher education; 0= otherwise |
| region1 | 1= Mediterranean Coast, excl. Balearic Islands; 0=otherwise (reference) |
| REGION2 | 1= Balearic Islands, Canary Islands, Ceuta and Melilla; 0=otherwise |
| REGION3 | 1= Region with Cantabric Coast (Northern and Northwestern); 0=otherwise |
| REGION4 | 1= Inner region; 0=coastal region |

Usually, unit values for each beverage are calculated by dividing expenditure by quantities. However, for 1980 and 1990 we use only the headings, the unit value method being not available. Yen and Huang (1996) use regional price data and four periods to obtain 36 different prices, avoiding the quality problem. We use price indices for 17 Regions, 3 years and 24 headings. In this way, different groups of food price indices for each household are obtained, and continuous series of prices with a lot of variation are available. The descriptive statistics of the dependent variables are shown in Table 2.

**Table 2: Demographic Variables**

| | 1980 | | 1990 | | 1998 | |
|---|---|---|---|---|---|---|
| | Mean | Std Dev | Mean | Std Dev | Mean | Std Dev |
| Seafood | 0.10 | 0.08 | 0.11 | 0.08 | 0.11 | 0.09 |
| Meat | 0.27 | 0.11 | 0.26 | 0.12 | 0.24 | 0.13 |
| Eggs&dairy | 0.15 | 0.07 | 0.13 | 0.07 | 0.12 | 0.08 |
| Other foods | 0.48 | 0.12 | 0.49 | 0.13 | 0.53 | 0.15 |

## THE MODEL

The censored demand system takes into account the possibility of non consumption. When cross-sectional data are used for demand analyses of specific products, a large number of zero purchases are expected due to the short period in which data are recorded. The reasons for recorded zero expenditure are infrequency of purchase, no participation, or a corner solution. Infrequency of purchase is because the survey period is too short to allow consumers to report any purchase of a specific product. No participation or abstention is due to consumers are not willing to buy the product. Corner solutions arise when consumers do not purchase the product at current prices and income levels. Shownkwiler and Yen (1999), Yen et al. (2002) and Yen and Lin (2006), develop some models compatible with the different causes of zero expenditure.

Instead of the translog demand system, as in the cited papers, we use the linear almost ideal model with quadratic expenditure term and demographic variables. The functional form of the (uncensored) demand system is

$$w_{it} = a_i + \Sigma_j\, b_{ij} \log p_{jt} + d_i \log(M_t) + .5\, e_i\, (\log(M_t))^2 + \Sigma_k\, a_{ik} x_{kt} \qquad (1)$$

The formulation of the censored demand system is:

$$\begin{aligned} s_{it} &= w_{it}(p_t, M_t, x_t; \theta) + \varepsilon_{it} \quad \text{if} \quad \Sigma_k\, \alpha_{ik} x_{kt} + \nu_{it} > 0 \\ &= 0 \qquad\qquad\qquad\qquad \text{if} \quad \Sigma_k\, \alpha_{ik} x_{kt} + \nu_{it} < 0 \\ & \qquad \text{corr}(\varepsilon_i, \nu_i) = \delta_i \end{aligned} \qquad (2)$$

The model explains the observed shares ($s_{it}$) as the theoretical shares ($w_{it}$) given a decision rule or participation equation for each consumption item, allowing correlation between the errors in the participation equation and in the share equation.

The model is estimated in two stages. Firstly, consistent probit estimates are computed using the participation equations

$$D_{it} = 1(\Sigma_k\, \alpha_{ik} x_{kt} + \nu_{it} > 0) \qquad (3)$$

The normal distribution $\Phi_{it}(\Sigma_k \alpha_{ik}x_{kt})$ and normal density $\phi_{it}(\Sigma_k \alpha_{ik}x_{kt})$ are computed for each observation and food item given the empirical estimates. These consistent estimates are included in the second stage, the estimation of the empirical demand system with share equations of the form

$$s_{it}= \Phi_{it}(.)w_{it}(p_t,M_t,x_t;\theta)+ \delta_i \phi_{it}(.)+\eta_{it} \quad (4)$$

where $w_{it}$ takes the form in (1). The model (4) can be estimated using seemingly unrelated regression or maximum likelihood methods. It is heteroscedastic and the parameters covariance matrix must be heteroscedasticity corrected (White, 1982).

## EMPIRICAL RESULTS

There is no economic theory to suggest the explanatory variables to include in the first and second steps of the decision model. Following Pudney (1989) a common underlying assumption is that the first hurdle is a function of non-economic factors determining household decisions to participate in the market. Therefore, the first set of probit variables consists of the socio-demographic variables in the censored demand system, without (logarithms of) prices and food expenditure. Taking into account that total effects of socio-demographics are based on marginal effects of equation (4), we present only a statistical summary of the parameters of probability and density of probability to purchase to be used in the censored demand equation, in Table 3.

**Table 3: Probit estimates of participation. Statistical summary**

| Participation | 1980 | | 1990 | | 1998 | |
|---|---|---|---|---|---|---|
| probability | Mean | Std Dev | Mean | Std Dev | Mean | Std Dev |
| $\Phi_1$ Seafood | 0.91 | 0.05 | 0.92 | 0.04 | 0.92 | 0.05 |
| $\Phi_2$ Meat | 0.99 | 0.02 | 0.99 | 0.01 | 0.98 | 0.02 |
| $\Phi_3$ Eggs&dairy | 0.99 | 0.01 | 0.98 | 0.01 | 0.98 | 0.01 |

| Participation | 1980 | | 1990 | | 1998 | |
|---|---|---|---|---|---|---|
| density | Mean | Std Dev | Mean | Std Dev | Mean | Std Dev |
| $\phi_1$ Seafood | 0.16 | 0.06 | 0.14 | 0.06 | 0.14 | 0.06 |
| $\phi_2$ Meat | 0.03 | 0.03 | 0.03 | 0.02 | 0.05 | 0.03 |
| $\phi_3$ Eggs&dairy | 0.03 | 0.02 | 0.04 | 0.02 | 0.05 | 0.03 |

We do not present detailed results of the second stage regressions because our analysis uses more specific coefficients, such as total marginal effects and elasticities. Table 4 shows the estimates of the correlation parameters. In general, there is positive dependency in the participation and share decisions. However, the effects for seafood are small, and significant only in 1980. The correlations are very high for eggs and dairy.

**Table 4: Estimates of the dependency correlation**

| | | 1980 | | 1990 | | 1998 | |
|---|---|---|---|---|---|---|---|
| | | Mean | Std Dev | Mean | Std Dev | Mean | Std Dev |
| $\delta_1$ | Seafood | **0.029** | 0.010 | 0.024 | 0.014 | 0.045 | 0.025 |
| $\delta_2$ | Meat | -0.036 | 0.036 | **0.441** | 0.081 | **0.254** | 0.053 |
| $\delta_3$ | Eggs&dairy | **0.323** | 0.042 | **0.346** | 0.040 | **0.438** | 0.052 |

Bold: statistically different from zero, p<.05.

The total marginal effects are used for the interpretation of results and computation of elasticity at the mean of the positive consumption sub samples. However, for expenditure and prices we can obtain more meaningful measures in elasticity terms. They are calculated based on derivatives of the observed shares $s_{it}$ in equation (4). Conventional formulae for elasticities are calculated using $w_{it}$. Taking into account that prices and expenditure do not explain the participation decision, derivatives of $\Phi_{it}(.)$ and $\phi_{it}(.)$ with respect to prices or expenditure are zero.

Food expenditure elasticities are presented in Table 5. Expenditure elasticity for seafood is stable, being seafood a luxury among food products. This indicates that the responsiveness of household expenditure on seafood to changes in food expenditure is not declining over time: an important result in forming expectations of future seafood consumption. Meat (luxury) and eggs and daily (necessity) show increasing elasticity, due perhaps to changes in composition and new products and presentations.

**Table 5: Food expenditure elasticities**

| | 1980 | | 1990 | | 1998 | |
|---|---|---|---|---|---|---|
| | Mean | Std Dev | Mean | Std Dev | Mean | Std Dev |
| Seafood | **1.28** | 0.02 | **1.23** | 0.01 | **1.25** | 0.02 |
| Meat | **1.11** | 0.01 | **1.14** | 0.01 | **1.19** | 0.01 |
| Eggs&dairy | **0.77** | 0.01 | **0.87** | 0.01 | **0.94** | 0.01 |
| Other food | **0.95** | 0.01 | **0.91** | 0.01 | **0.87** | 0.01 |

Bold: statistically different from one, p<.05.

Own price elasticity for seafood is very slightly above one, and not different from one at p=.05 in 1990 and 1998. This result is in sharp contrast with that in Millán and Aldaz (2006), in only seafood models, with seafood demand inelastic in 1980 and becoming elastic in 1998. Meat demand and other food demand are increasingly own price elastic. Eggs and dairy demand has changed from very elastic in 1980 to very inelastic in 1998.

**Table 6: Uncompensated elasticities**

1980

| | Seafood | | Meat | | Eggs&dairy | | Other foods | |
|---|---|---|---|---|---|---|---|---|
| | Mean | St.dev | Mean | St.dev | Mean | St.dev | Mean | St.dev |
| Seafood | **-1.16** | 0.06 | **0.65** | 0.06 | **-0.18** | 0.05 | **-0.59** | 0.07 |
| Meat | **0.28** | 0.03 | **-1.24** | 0.05 | **0.49** | 0.03 | **-0.64** | 0.05 |
| Eggs&dairy | -0.07 | 0.04 | **1.06** | 0.06 | **-2.70** | 0.07 | **0.94** | 0.06 |
| Other foods | **-0.10** | 0.02 | **-0.33** | 0.03 | **0.25** | 0.02 | **-0.77** | 0.04 |

1990

| | Seafood | | Meat | | Eggs&dairy | | Other foods | |
|---|---|---|---|---|---|---|---|---|
| | Mean | St.dev | Mean | St.dev | Mean | St.dev | Mean | St.dev |
| Seafood | **-1.20** | 0.12 | **0.35** | 0.11 | **-1.15** | 0.09 | **0.75** | 0.14 |
| Meat | **0.20** | 0.06 | **-1.17** | 0.09 | **-0.30** | 0.06 | 0.12 | 0.09 |
| Eggs&dairy | **-1.09** | 0.09 | **-0.53** | 0.12 | **-1.69** | 0.16 | **2.42** | 0.15 |
| Other foods | **0.23** | 0.03 | **0.11** | 0.05 | **0.59** | 0.04 | **-1.86** | 0.07 |

1998

| | Seafood | | Meat | | Eggs&dairy | | Other foods | |
|---|---|---|---|---|---|---|---|---|
| | Mean | St.dev | Mean | St.dev | Mean | St.dev | Mean | St.dev |
| Seafood | **-1.11** | 0.19 | **-0.64** | 0.17 | **-1.60** | 0.15 | **2.07** | 0.23 |
| Meat | **-0.31** | 0.09 | **-2.18** | 0.16 | **-0.77** | 0.09 | **2.05** | 0.15 |
| Eggs&dairy | **-1.71** | 0.15 | **-1.56** | 0.20 | 0.05 | 0.27 | **2.27** | 0.28 |
| Other foods | **0.51** | 0.05 | **0.95** | 0.07 | **0.44** | 0.06 | **-2.80** | 0.10 |

Bold: statistically different from zero, p<.05.

Cross price elasticities reflect important taste changes since early 80s. Seafood is only a substitute for meat and a complement for eggs and dairy and for other food in 1980. In 1990, other food becomes complement and eggs and dairy is substitute. In 1998, seafood is a strong complement for meat and egg and dairy products, with very high substitution for other food. The evolution towards animal proteins complementarities with other food substitution is observed with meat and eggs and dairy, too. Probably, there is no single explanation behind these changes. A first one is related to changes in attitudes towards proteins and health concerns. A second explanation is based on changes in purchasing behaviour (supermarkets, less shopping frequency …).

Compared to the effects of major economic variables, the evidence on socio-demographic characteristics seems less interesting, as shown for seafood in Table 7. These are calculated using derivatives from equation (4) with coefficients estimated in the first and in the second stage. The results are qualitatively very similar in the three samples, except perhaps concerning rural/urban issues, with relative decline in rural areas. Thus, there is relatively little taste change concerning demographic characteristics.

**Table 7: Demographic effects, Seafood**

| | 1980 | | 1990 | | 1998 | |
|---|---|---|---|---|---|---|
| | Estimate | Std.Dev. | Estimate | Std.Dev. | Estimate | Std.Dev. |
| SEX | **0.015** | 0.002 | **0.013** | 0.002 | **0.007** | 0.003 |
| LOG_AGE | **0.026** | 0.002 | **0.046** | 0.002 | **0.043** | 0.004 |
| PERSONS | **-0.018** | 0.001 | **-0.019** | 0.002 | **-0.021** | 0.003 |
| HABITAT2 | 0.002 | 0.001 | 0.003 | 0.002 | **0.016** | 0.003 |
| HABITAT3 | **-0.007** | 0.002 | **0.010** | 0.002 | **0.009** | 0.002 |
| STUDY1 | **0.008** | 0.001 | 0.003 | 0.002 | 0.005 | 0.003 |
| STUDY3 | **0.025** | 0.001 | **0.026** | 0.001 | **0.021** | 0.004 |
| REGION2 | **0.013** | 0.003 | **0.004** | 0.002 | **0.010** | 0.004 |
| REGION3 | **0.030** | 0.002 | **0.028** | 0.002 | **0.038** | 0.003 |
| REGION4 | **0.023** | 0.001 | **0.024** | 0.002 | **0.030** | 0.002 |

Bold: statistically different from zero, $p<.05$.

The results indicate that seafood consumption is positively related to the age of the household head, and negatively related to be a woman the household, and to household size. Seafood consumption increases with the education level of the household head, although the differences concerning education level are declining.

The regional effects are positive with respect to consumption in the Mediterranean are as reference. This illustrates that REGION4 (Inner Spain) is very important in seafood consumption, with higher consumption than in the coastal Mediterranean area. Seafood consumption in REGION3 (Northern and Northwestern Coastal Regions) is very important too..

Demographic effects for other items are shown in Table 8. A comparison with Table 7 confirms the idea that demographic changes for seafood are relatively unimportant. Change is more significant qualitatively and quantitatively for other products.

**Table 8: Other demographic effects**

1980

| | Meat | | Eggs&Dairy | | Other food | |
|---|---|---|---|---|---|---|
| | Estimate | Std.Dev. | Estimate | Std.Dev. | Estimate | Std.Dev. |
| SEX | 0.003 | 0.003 | **0.014** | 0.002 | -0.004 | 0.003 |
| LOG_AGE | **0.007** | 0.003 | **-0.011** | 0.002 | **0.026** | 0.002 |
| PERSONS | **-0.019** | 0.002 | **0.048** | 0.002 | **0.020** | 0.003 |
| HABITAT2 | **0.015** | 0.002 | -0.002 | 0.001 | **0.015** | 0.002 |
| HABITAT3 | **0.028** | 0.003 | **-0.007** | 0.002 | **0.017** | 0.003 |
| STUDY1 | **-0.006** | 0.002 | **0.003** | 0.001 | **0.023** | 0.002 |
| STUDY3 | **0.005** | 0.002 | **0.005** | 0.001 | **-0.008** | 0.002 |
| REGION2 | **-0.036** | 0.004 | 0.003 | 0.003 | **0.049** | 0.004 |
| REGION3 | **0.021** | 0.002 | **0.013** | 0.001 | **-0.036** | 0.002 |
| REGION4 | **0.038** | 0.002 | **0.013** | 0.001 | **-0.047** | 0.002 |

1990

| | Meat | | Eggs&Dairy | | Other food | |
|---|---|---|---|---|---|---|
| | Estimate | Std.Dev. | Estimate | Std.Dev. | Estimate | Std.Dev. |
| SEX | -0.003 | 0.003 | **0.013** | 0.002 | **0.007** | 0.003 |
| LOG_AGE | 0.004 | 0.003 | **-0.012** | 0.002 | **0.046** | 0.002 |
| PERSONS | **0.012** | 0.003 | **0.036** | 0.002 | 0.002 | 0.004 |
| HABITAT2 | **0.015** | 0.003 | 0.003 | 0.002 | **0.010** | 0.004 |
| HABITAT3 | **0.035** | 0.003 | **-0.005** | 0.002 | **-0.010** | 0.004 |
| STUDY1 | 0.000 | 0.002 | **0.008** | 0.001 | **0.020** | 0.003 |
| STUDY3 | -0.003 | 0.002 | 0.002 | 0.001 | 0.004 | 0.002 |
| REGION2 | **-0.025** | 0.003 | **0.023** | 0.002 | **0.028** | 0.004 |
| REGION3 | **0.030** | 0.002 | **0.022** | 0.002 | **-0.053** | 0.003 |
| REGION4 | **0.051** | 0.002 | **0.007** | 0.001 | **-0.055** | 0.002 |

1998

| | Meat | | Eggs&Dairy | | Other food | |
|---|---|---|---|---|---|---|
| | Estimate | Std.Dev. | Estimate | Std.Dev. | Estimate | Std.Dev. |
| SEX | 0.006 | 0.004 | **0.011** | 0.003 | 0.008 | 0.005 |
| LOG_AGE | **0.031** | 0.005 | **-0.006** | 0.003 | **0.043** | 0.004 |
| PERSONS | -0.002 | 0.004 | **0.029** | 0.004 | **0.030** | 0.006 |
| HABITAT2 | 0.003 | 0.003 | 0.003 | 0.002 | **0.011** | 0.004 |
| HABITAT3 | **0.016** | 0.003 | **0.007** | 0.002 | 0.000 | 0.004 |
| STUDY1 | **0.022** | 0.004 | **0.007** | 0.003 | -0.002 | 0.005 |
| STUDY3 | -0.008 | 0.005 | **0.015** | 0.003 | 0.003 | 0.006 |
| REGION2 | -0.007 | 0.005 | **0.025** | 0.003 | 0.003 | 0.006 |
| REGION3 | **0.047** | 0.003 | **0.021** | 0.002 | **-0.079** | 0.004 |
| REGION4 | **0.045** | 0.003 | -0.003 | 0.002 | **-0.043** | 0.004 |

Bold: statistically different from zero, p<.05.

## CONCLUSIONS

Seafood consumption at home in Spain is analysed using two stage estimation of censored demand system for seafood, meat, eggs&dairy and other foods with surveys in 1980, 1990 and 1998, The estimated price and expenditure elasticities show that fundamental economic factors are more interesting and valuable than demographic or socio-economic changes in explaining changes in animal consumption in Spain.

An unexpected result for seafood is the stability of own price elasticity slightly and not statistically different from one. Meat is substitute for seafood in the 80s and complement in 98. Eggs and dairy becomes complement for seafood too in the 90s. It is very interesting that the evolution of food expenditure elasticity for seafood is not decreasing.

Concerning demographic effects in seafood consumption, there are very similar patterns in the three surveys. Seafood consumption is higher with age and education level of the household head. Geographically, seafood consumption is higher in northern coastal regions and inner Spain. On the contrary, seafood consumption is lower related to household size, with a woman as household head, and, recently, in rural areas.

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