www.eafe-fish.eu

The XVIIIth Annual EAFE Conference

A DEMAND ANALYSIS FOR FARMED FISH IN SPAIN

Joaquín A. Millán, Technical University of Madrid UPM,
joaquin.millan@upm.es
Natalia Aldaz, University of Lleida, UdL
natalia@aegern.udl.es

ABSTRACT

In this paper, we study a complete demand system for fish species with mainly aquaculture production in Spain, using a recently available data basis from January- 2004 to December-2006. Several specifications of the linear almost ideal demand model are tested. Own price demand for gilthead seabream, seabass, trout and salmon are elastic. Turbot and sole (unimportant now, but aquaculture target) are price inelastic. There is a complex and interesting complementarity pattern.

Keywords: Spanish fish consumption, aquaculture.

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

31th August 2007

A DEMAND ANALYSIS FOR FARMED FISH IN SPAIN

INTRODUCTION

Spain is the biggest fish market in Europe, with fluctuating trends in consumption and declining self-supply rate. Most of the descriptive studies on seafood consumption in Spain have used the Consumption Panel of the Spanish Ministry for Agriculture, Fisheries and Food (MAPYA). Details can be found on the web (www.mapa.es). This Consumption Survey begins in 1987, but both the methodology and the items examined have changed several times. Until now, the detailed socio-demographic characterisation has been exploited, mainly at a fairly aggregated level concerning species.

Millán (2002) summarises the main characteristics and evolution of the Spanish seafood consumption in 1998 over the previous decade. The Spanish market for aquatic food products is characterised by the dominance of fresh food. Farmed fish consumed in Spain are mainly sourced from domestic production (trout, seabass, gilthead seabream and turbot), but they are imported too (salmon, and the same species of Spanish origin. The Spanish fish consumer is very price sensitive according to the descriptive literature.

The technical literature on demand of fish species in Spain is very limited. There several papers using fish landings and inverse demand systems (Millán and Aldaz, 1998; Nielsen, 1999). Bjørndal et al. (1994) analyse the structure of demand for farmed salmon in Spain. On the other hand, Alfranca et al. (2004) analyse price dynamic between farmed and wild gilthead seabream in Spain.

The objective of this paper is to characterise farmed fish consumption in Spain at a species level in three issues: price and expenditure response, seasonality and recent trends. The study of price elasticity is required to measure the recognised price sensitivity of the Spanish consumer. Seasonality of fish consumption is an interesting issue concerning fish consumption in countries with long fish consumption tradition (Wessels and Wilen, 1994). Finally, other factors can determine short trends, in special at a species level.

The structure of this paper is as follows. In the next section, the data are introduced. It follows the econometric specification 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

This paper uses a recently available data basis from the Food Consumption Panel of MAPA (Ministry for Agriculture, Fisheries and Food) with new methodology. In particular, we take 36 monthly observations from January-2004 to December-2006 of price and per capita consumption of the following fish species in Spain: seabass, gilthead seabream, turbot, trout, sole, and salmon. Trout and salmon are almost totally farmed; seabass, gilthead seabream and turbot consumption is more than 80% (close to 90% for gilhead seabream) from aquaculture. Sole is mainly wild but it is a target aquaculture species in Spain. Other species, almost totally from catches are aggregated in other fish.

Table 1. Statistical summary.

	P (€/KG)		Q (KG/CAP)		SHARE (%)	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
SEABASS	7.51	0.41	0.028	0.009	3.40	0.01
GILTHEAD SEABREAM	6.83	0.41	0.047	0.011	5.24	0.01
TURBOT	8.87	0.80	0.005	0.002	0.76	0.00
TROUT	4.23	0.32	0.037	0.008	2.59	0.00
SALMON	6.98	0.83	0.055	0.013	6.32	0.01
SOLE	7.97	0.56	0.109	0.014	14.33	0.01
OTHER FISH	5.64	0.19	0.720	0.068	67.36	0.02

Table 1 shows a statistical summary of the species in our analysis. Excepting trout, farmed fish species belong to the upper segment of the market with prices above the average fish price in Spain. The interest of farmed sole is clear given the sole share in the Spanish fish consumption

THE MODEL

Concerning possible functional forms, we look for a demand system able to provide a realistic picture of the substitution, own price and expenditure effects, and seasonal and trend effects, that may arise after a change in the structure of relative prices. A simple extension of the Linear Almost Ideal System in budget shares is given by

$$w_{it} = \Sigma_k a_{ik} D_{kt} + \Sigma j\ b_{ij} \log p_{jt} + d_i \log(M_t/P_t) + a_{it}\, t \qquad (1)$$

M, **p** are total fish expenditure and prices, respectively, and t is a time trend centred in mid-sample, D_k is a seasonal monthly variable. P is measured by the Laspeyres-like index analyzed in Moschini (1995) and Asche and Wessels (1998)

$$\log P_t = \Sigma_i w_{i0} \log(p_{it}/p_{i0}) \qquad (2)$$

The model embodies theoretical restrictions as adding up (which is satisfied automatically by the system if it is estimated by linear methods), homogeneity and symmetry (that can be imposed and tested as restrictions on the parameter vectors) and negativity (which cannot be imposed but can be tested looking at the sign of the Slutsky matrix). The theoretical restrictions impose constraints on the equation system:

Adding-up $\Sigma_i a_{ik} = 1,\ \Sigma_i a_{it} = 0,\ \Sigma_i b_{ij} = 0,\ \Sigma_i d_i = 0$ (3)

Homogeneity $\Sigma_j b_{ij} = 0$ (4)

Symmetry $b_{ij} = b_{ji},\quad i \neq j$ (5)

The formulae for elasticities at the normalization point are, with $a_i = \Sigma_k a_{ik}/12$:

Expenditure $f_i = \dfrac{d_i}{a_i} + 1$ (6)

Compensated $$e_{ij}^{*} = -ä_{ij} + \frac{b_{ij}}{a_i} + a_j \quad (7)$$

Uncompensated $$e_{ij} = -ä_{ij} + \frac{b_{ij}}{a_i} - \frac{d_i}{a_i} a_j \quad (8)$$

EMPIRICAL RESULTS

We estimate the above model with the data explained in section 2. Since the data add up, the conditional errors also sum to 0 and the conditional covariance matrix is singular. To overcome this singularity problem, an arbitrary equation must be omitted from the system. The system of seven conditional demand equations is estimated by maximum likelihood methods. The equation for other fish is deleted to ensure nonsingularity of the error covariance matrix. The coefficients of the omitted equation are recovered by using the estimated coefficients of the other six equations and the theoretical restrictions (3). Firstly, we estimate the model in (1), but the expenditure elasticities, although sensible (turbot as a luxury, trout as a necessity…) aro not statistically different from one. The log-likelihood at the maximum is 1006.9. The restricted unitary elasticity model (with d_i =0 for all i) gives 1005.7 as the maximum log-likelihood. Clearly the hypothesis of unitary elasticity is not rejected. The following results are based on the model of unitary expenditure elasticity. Table 2 shows reasonable goodness of fit statistics, R^2 coefficients ranging between 0.79 for sole and 0.95 for seabass, and without heteroscedasticity or autocorrelation problems.

Table 2. Goodness of fit statistics.

	R^2	LM het.	DW
SEABASS	0.953	1.23	1.86
GILTHEAD SEABREAM	0.823	0.32	1.36
TURBOT	0.842	1.86	1.73
TROUT	0.946	0.01	2.67
SALMON	0.876	0.08	1.88
SOLE	0.787	0.28	2.53
OTHER FISH	0.936	-	-

The detailed results of the estimations are presented in two parts. Firstly, those parameters related to substitution, and later those related with seasonality and trends. Table 3 shows the parameters estimates concerning substitution. The parameter a_i is $(\Sigma_j a_{ij}/12)$. Seventeen out from twenty nine parameters are statistically different from zero.

Table 3. Parameter estimates.

1 SEABASS 2 GILTHEAD SEABREAM 3 TURBOT

4 TROUT 5 SALMON 6 SOLE 7 OTHER FISH

Parameter	Estimate	Std.Dev.	Parameter	Estimate	Std.Dev.
A1	**0.034**	0.000	B33	0.004	0.004
B11	**-0.065**	0.013	B34	0.000	0.003
B12	**0.033**	0.012	B35	-0.009	0.007
B13	-0.009	0.005	B36	**0.020**	0.007
B14	0.006	0.007	A4	**0.026**	0.000
B15	**-0.040**	0.011	B44	**-0.020**	0.009
B16	-0.013	0.011	B45	**0.017**	0.006
A2	**0.052**	0.001	B46	**-0.016**	0.006
B22	-0.045	0.028	A5	**0.063**	0.001
B23	0.012	0.008	B55	**-0.075**	0.027
B24	0.010	0.008	B56	**-0.040**	0.020
B25	**0.082**	0.020	A6	**0.143**	0.001
B26	0.009	0.020	B66	**0.060**	0.030
A3	**0.008**	0.000			

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

Coefficients from share equation models such as those are difficult to interpret. All quantities have been scaled according to their geometric mean before estimation. Therefore, the flexibility formulae are evaluated at the sample geometric means of the data, as functions of estimated parameters. Table 4 and Table 5 show compensated and uncompensated elasticities, respectively. Although expenditure elasticity is one, there is some scope for differences between compensated and uncompensated elasticities taking into account the large shares of sole and mainly other fish.

Table 4. Compensated elasticities

		1	2	3	4	5	6	7
1	SEABASS	**-2.86**	**0.67**	-1.15	0.25	**-0.60**	-0.06	**0.16**
2	GILTHEAD SEABREAM	**1.03**	**-1.80**	1.63	0.43	**1.36**	0.12	**-0.10**
3	TURBOT	-0.26	0.24	-0.43	0.00	-0.13	**0.15**	-0.02
4	TROUT	0.19	0.21	0.01	**-1.75**	**0.30**	-0.09	**0.03**
5	SALMON	**-1.11**	**1.64**	-1.08	**0.73**	**-2.13**	-0.22	**0.16**
6	SOLE	-0.25	0.31	**2.81**	-0.49	-0.49	**-0.44**	**0.11**
7	OTHER FISH	**3.25**	**-1.27**	-1.79	**0.83**	**1.69**	**0.54**	**-0.35**

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

Own price response is very elastic for the different aquaculture species, excepting turbot. Sole and the aggregate other fish are price inelastic. These results enhance the idea that the Spanish fish consumer is price sensitive. In fact, it is very price sensitive with respect to farmed fish.

The cross price effects show a rich pattern of interactions. Seabass and gilthead seabream are substitute, as expected but differ respect to salmon (gilthead seabram substitute, seabass complement) and to other fish (gilthead seabram complement, seabass substitute). In addition, salmon is slightly substitute for trout and for other fish. The cross effects for salmon are interesting, because Bjørndal et al. (1994) did not observe substitution of salmon for other fish species in Spain. Sole and turbot are substitute, a reasonable result at the upper price level.

Table 5. Uncompensated elasticities

		1	2	3	4	5	6	7
1	SEABASS	**-2.90**	**0.63**	-1.18	0.22	**-0.63**	-0.09	**0.13**
2	GILTHEAD SEABREAM	**0.98**	**-1.85**	1.58	0.38	**1.30**	0.06	**-0.15**
3	TURBOT	-0.26	0.23	-0.44	0.00	-0.14	**0.14**	**-0.03**
4	TROUT	0.17	0.19	-0.02	**-1.78**	**0.27**	**-0.11**	0.01
5	SALMON	**-1.17**	**1.57**	-1.15	**0.66**	**-2.19**	**-0.28**	**0.10**
6	SOLE	-0.39	0.17	**2.67**	**-0.63**	**-0.63**	**-0.58**	-0.03
7	OTHER FISH	**2.58**	**-1.94**	**-2.46**	0.15	**1.01**	-0.14	**-1.02**

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

Table 6 shows seasonal and trend effects. Seasonal effects are adjusted with respect mean a_i and multiplied to present the results in percentage. As an example, seabass share in fish consumption is in January .65% and in December 1.71% more than average and in August 1.09% less than average, other things equal.

Table 6. Seasonals and trends (x100)

	SEABASS	SEABREAM	TURBOT	TROUT
January	**0.65**	**0.85**	0.02	**0.47**
February	-0.00	0.11	-0.14	0.20
March	0.26	-0.40	-0.04	0.15
April	0.02	**-0.78**	-0.16	0.08
May	**-0.31**	**-0.77**	-0.19	**0.52**
June	-0.24	**-1.07**	**-0.23**	**0.22**
July	**-0.92**	**-0.79**	0.10	**-0.20**
August	**-1.09**	0.16	-0.11	-0.10
September	**-0.58**	-0.19	0.04	**-0.23**
October	-0.07	0.51	-0.16	-0.07
November	**0.58**	**0.70**	-0.09	**-0.27**
December	**1.71**	**1.68**	**0.96**	**-0.78**
Std.Dev_M	0.14	0.28	0.10	0.07
T	**0.046**	0.005	0.001	**-0.024**
Std.Dev_T	0.004	0.008	0.003	0.002
	SALMON	SOLE	OTHER FISH	
January	0.60	0.27	**-2.86**	
February	**-0.70**	**1.54**	-1.01	
March	-0.54	0.74	-0.17	
April	-0.61	0.53	**0.92**	
May	-0.18	0.49	0.44	
June	-0.61	0.90	**1.04**	
July	**-1.11**	**-0.81**	**3.74**	
August	-0.55	-0.79	**2.48**	
September	-0.43	**-0.93**	**2.32**	
October	0.35	0.02	-0.59	
November	**0.86**	0.22	**-2.00**	
December	**2.92**	**-2.18**	**-4.30**	
Std.Dev_M	0.30	0.38	0.43	
T	**-0.025**	**-0.034**	**0.030**	
Std.Dev_T	0.009	0.011	0.013	

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

The main result is best observed looking at other fish monthly coefficients. They are positive and large (3.74% share increase in July) in summer and very large and negative in winter (-4.3% share decrease in December). This means that farmed fish share is larger in winter and lesser in summer. The results for seabass have been observed above. Gilthead seabream exhibits a similar pattern, although the large decrease is not in summer but in spring. December increases for salmon (2.92%) and especially for turbot (.96%, more than double than average share) are very important. On the contrary, sole share decreases in December and increases in February.

The trend term is interpreted in a similar way. As example, other things equal, seabass share increase .046% each month (increasing 1.66% in three years!). It is observed a statistically significant increasing trend for seabass and other fish, only. Trout and salmon exhibit similar decreasing trends, and there is no trend for gilthead seabream and turbot. Perhaps, there is some saturation at current price levels. It is remarkable that the trend for sole is decreasing, a handicap for a target species, although its current share is still high.

CONCLUSIONS

This paper has characterised current consumption for farmed fish in Spain using a demand system modelling approach. Farmed fish species are very own price elastic, except for the most valuable (turbot and sole, target species). It has been found a very rich substitute and complement pattern, contrary to the previous salmon demand literature. These findings illustrate that the Spanish farmed fish consumer is very prie sensitive.

Seasonal effects and short-term trends have been analysed too. The main finding on monthly consumption is that farmed fish shares increase in winter with respect to other fish consumption shares. Seabass share is increasing strongly, but there is no significant trend for gilthead seabream and turbot. Trout and salmon show a decreasing trend. There is perhaps some saturation with respect to the best known farmed species.

As a limitation of the results, expenditure effects, although sensible in value, are not significant from a statistical point of view. This limitation suggests that some gains can be expected from alternative approaches. Perhaps an analysis including regional differentiation, very important in seafood consumption in Spain, could help in more efficient estimates of expenditure elasticity. Another possibility, although it appears difficult from a technical point of view, is to include household participation shares in the model.

REFERENCES

Alfranca, O., J. Oca and L. Reig, 2004. Product differentiation and dynamic price behavior in fish markets. *International Advances in Economic Research* 10: 150-158.

Asche, F. and C.R. Wessells, 1997. On price indices in the almost ideal demand system. *American Journal of Agricultural Economics,* 79:1182-85.

Bjørndal T., K. G. Salvanes, and D. V. Gordon, 1994. Elasticity estimates of farmed salmon demand in Spain and Italy. *Empirical Economics,* 19: 419-428.

Millán, J.A., 2002, MASMANAP country report: Spain. *Cahiers Options Méditerrannées. Seafood market studies for the introduction of new aquaculture products.* 59: 265-288.

Millán J.A, and N. Aldaz N.,1998, An Analysis of Demand for Fresh and Frozen Fish Species in Spain, *IIFET1998 Conference*. Trømsø

Moschini, G., 1995. Units of measurement and the Stone price index in demand system estimation. *American Journal of Agricultural Economics,* 77: 63-68.

Nielsen, M., 1999. EU Seafood Demand. *XIth Annual Conference of the European Association of Fisheries Economists.* Dublin.

Wessels, C.R. and J.E. Wilen, 1994. Seasonal Patterns and Regional Preferences in Japanese Household Demand for Seafood, *Canadian Journal of Agricultural Economics,* 42: 87-103.