A FRAMEWORK FOR THE MEDITERRANEAN SWORDFISH PRICE FORMATION

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The price function into the simulation framework

Following the approximation to the price equations discussed in Athens and also gathered by IREPA Onlus (V. Placenti, 2006), prices are broken down by species and by fishing system. Generally speaking, price dynamics can follow two different hypotheses:

-In the former case, the prices by fishing system are assumed as constant and equal to the prices registered over the base year:

$$p_{spe,sis,t} = \overline{p}_{spe,sis} .$$

Constant prices can be used for the secondary species included in the model.

-In the second case, the one that we are going to develop for swordfish, prices are assumed as a function of the quantity produced, that is, the catches. **The functional relation between prices and catches is defined using a flexibility coefficient per each species and fishing system ($\alpha_{spe,sis}$). The flexibility coefficients are to be estimated off-line and included in the model as input parameters**. The flexibility between prices and catches is considered as the per cent variation in prices due to the unitary per cent variation in catches:

$$p_{spe,sis,t} = p_{spe,sis,t-1}\left(1+\alpha_{spe,sis}\frac{C_{spe,sis,t}-C_{spe,sis,t-1}}{C_{spe,sis,t-1}}\right);$$

where $\alpha_{spe,sis}$ is the flexibility coefficient per a given species and fishing system.

A priory no differentiation by commercial category associated to the length classes of the swordfish is considered.

Inverse demand and price flexibilities

Prices are determined by supply and demand. On capture fish markets, supply is affected mainly by bio-economy, weather, and fisheries management conditions. Supply is very inelastic in the short run and the producers are virtually price takers, so *supply is only to a* *limited extent affected by prices*. Fishermen supply what they catch and the market has to adjust thereafter.

Price taking producers and price taking consumers are linked by traders who select a price which they expect clears the market. In practice this means that at the auction the wholesale traders offer prices for the fixed quantities which, after being augmented with a suitable margin, are sufficiently low to induce consumers to buy the available quantities. The traders set the prices as a function of the quantities. The causality goes from quantity to price.

As quantity supplied is considered (exogenously) given at the market level, the demand is determined by income and preferences and can be modeled in ordinary and inverse way. Most studies of the demand for fish have assumed that the price is determined by the quantity available rather than the reverse. So the inverse demand appears to be a very natural model for the price formation of quickly perishable goods for which the quantities cannot adjust in the short run as is the case of fish.

"Off-line" estimation of the flexibility coefficients

Given that our goal consists on getting price flexibilities and introduce them in a more general and complex simulation framework (that includes the dynamics of the stock, catches, fleets, management, etc…), one of the most appropriate specification for swordfish would be a single inverse demand equation. The linear, the Cobb-Douglass (double-log), the log-lin and the lin-log type of models have been the most popular functional forms in demand studies dealing with single inverse demand equations of fish. But there is no a priori reason to choose one form over the other and also to restrict to these particular choices, so a generalized procedure known as Box-Cox transformation (1964) is used to select the appropriate functional form.

In this case an inverse double-log demand function has been estimated for the Mediterranean-swordfish using Ordinary Least Squares (OLS) on monthly data from January-2001 to September-2006 (78 observations) from Spanish fish auctions. The problem of biased OLS estimations due to the identification problem, or simultaneous equations bias, that comes from the simultaneity between the variable own-price and the variable quantity is avoided (exogenous supply) and it is not necessary to employ the method of moments for estimation (Two-Stage Least Squares or Instrumental Variable Estimation).

The variables considered in the model are ex-vessel prices and quantities landed by the Spanish long line fleet operating in the Mediterranean sea, as well as other exogenous variables such as total expenditure and imported quantities of swordfish by Spain. These data do not gather any differentiation by commercial category associated to the length classes of the swordfish.

The aggregation and symmetry restrictions that come from the theory of consumer behavior are cross-equation restrictions, requiring the estimation of a complete system before they can be tested or enforced. If attention is concentrated on a single equation, the only restrictions that can be made use of are those of homogeneity and negativity. Taking into account that homogeneity is the strongest restriction in the single demand equation context (in the sense of having the greatest chance of being rejected) and is therefore of the most interest, this restriction has been imposed prior to estimation. This implies accepting that demand is a function of relative prices and real total expenditure.

* <u>*Definition of variables*</u>:

$P_{MED\text{-}SWO\text{-}LL}$: Ex-vessel prices of Mediterranean-swordfish caught by the Spanish long line fleet operating in the Mediterranean sea (€/kg).

P : General price of swordfish (Weighted average price of total Swordfish in the market –from different origins and fishing systems-) (€/kg).

$Q_{MED\text{-}SWO\text{-}LL}$: Quantity of Mediterranean-swordfish landed by the Spanish long line fleet (kg).

$Q_{SWO\text{-}IMP}$: Quantity of swordfish imported by Spain (kg).

$P_{MED\text{-}SWO\text{-}LL} / P$: Relative price of swordfish (price of Med-swordfish caught by the long line fleet and average price of total swordfish in the market)

$EXPEND_{SWO} / P$: Real total expenditure in swordfish (taking into account total landings of different origins and fishing systems plus Net Imports of Spain).

* <u>*Results*</u>:

Model : OLS estimates using the 78 observations 2000:01-2006:06
Dependent variable: ln ($P_{MED\text{-}SWO\text{-}LL}$ / P)

Variable	*Coefficient*	*Std. Error*	*t-statistic*	*p-value*	
Const	-0.328703	0.407882	-0.8059	0.42290	
ln $Q_{MED\text{-}SWO\text{-}LL}$	**-0.0923474**	0.0131852	-7.0039	<0.00001	***
ln $Q_{SWO\text{-}IMP}$	-0.193074	0.0389445	-4.9577	<0.00001	***
ln ($EXPEND_{SWO}$ / P)	0.297494	0.0412163	7.2179	<0.00001	***

Mean of dependent variable = 0.140926
Standard deviation of dep. var. = 0.254624
Sum of squared residuals = 2.16212
Standard error of residuals = 0.170932
Unadjusted R^2 = 0.566899
Adjusted R^2 = 0.549341
F-statistic (3, 74) = 32.2869 (p-value < 0.00001)
Durbin-Watson statistic = 1.75372
First-order autocorrelation coeff. = 0.0995986
Log-likelihood = 29.1619
Akaike information criterion = -50.3238
Schwarz Bayesian criterion = -40.897
Hannan-Quinn criterion = -46.5501

In an inverse demand framework, where the variables are expressed in logarithms, the estimated coefficients are the own-price, the cross-price and the scale flexibilities:

The *Own price flexibility* ($\alpha_{sm\text{-}swo}$) is the percentage change in the *i*th commodity's normalized price due to a 1 per cent change in the quantity consumed of that commodity. **In this case, as the med-swordfish own price flexibility ($\alpha_{sm\text{-}swo}$) is equal to -0,0923474, we can say that the demand for Mediterranean swordfish is inflexible.**

The *Cross price flexibility* is the percentage change in the *i*th commodity's normalized price due to a 1 per cent change in the consumption of the commodity *j*. The cross price flexibility of imported swordfish is negative, -0.193074, meaning that the imported swordfish is a substitute of the Mediterranean-swordfish caught by national longliners.

Finally, the *Scale flexibility* is the percentage change in the *i*th commodity's normalized price due to a 1 per cent change in the scale of consumption (total expenditure). The scale flexibility is equal to 0.297494.