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EU Seafood Demand

Max Nielsen

Danish Institute of Agricultural and Fisheries Economics

Abstract.

The purpose of the paper is to create a preliminary base from which an Economic Model of EU Seafood Demand can be constructed. This is done through a literature review of existing neo-classical studies of EU seafood demand 1980-96. Many demand studies are known, but almost all have been drawn up for market segments in single EU countries. Applied ordinary and inverse demand models are reviewed and it is argued that the inverse model is superior on fish markets, as supply is presumed to be determined by bio-economy, weather and fishery regulations. In the reviewed studies price flexibilities are estimated from –1 to 0. For example, a 10% quota reduction causes a 0-10% price increase, 2.7% on average. Results differ according to different aggregation levels, different size and share of examined markets and different degrees of market delineation on those markets. Seafood as a whole and pelagic fish are found to be necessary goods, salmon a luxury good, and smoked mackerel an inferior good. Codfish is a good with homothetic preferences.

Keywords:

EU, Seafood, Demand, Economic Model.

1. Introduction

The Fisheries Policies in Denmark and other EU countries strongly affect the Fishing Industry through conservation, market and trade policies. The Policies affect the behaviour in the Fishing Industry through restrictions on catches and access, through reference prices and through protection of imports. Therefore if one had to evaluate the economic effect of changing policies, knowledge of the economic behaviour is necessary. This paper is a review of literature concerning economic behaviour on EU Seafood Markets. The focus is on traditional neo-classic commodity market analysis with the application of Demand models with exogenous supply. The purpose is to create a basis from which an Economic Model of EU Seafood Demand, to evaluate changes in fisheries policies, can be constructed. This is done through the description and assessment of:

- applied demand models
- empirical estimations of behavioural relations on seafood markets, elaborated after 1980
- empirical estimations related to applied models.

Behavioural relations are price and income elasticises, and price and scale flexibilities. Empirical estimations are assessed in relation to the functional form, static/dynamic model, applied econometric method and inverse/ordinary models. The description tends to include all EU countries, but is affected by the fact that almost all existing literature has been worked out for market segments in single EU countries. One example is Jøgensen et. al. (1989), with their study of price formation on Scottish ex-vessel cod and haddock markets.

This paper is separated in six sections. In section two, applied models are described. In sections three and four data and empirical results are described. In section five the implications for formation of an Economic Model of EU Seafood Demand is discussed. Conclusions are drawn in section six.

2. Applied Demand Theory

In the literature a number of empirical surveys of seafood demand have been worked out since 1960. The earliest known surveys have been worked out in USA and include among others Bell (1968), Nash and Bell (1969) and Bockstael (1977). After 1980 a number of surveys were performed in USA, Canada, Japan and in Europe. The purpose of this section is to describe models applied after 1980 to analyse behaviour on EU seafood markets. Surveys built on traditional neo-classical commodity market analysis are described. That is, models built on both normal and compensated demand, and models built as both inverse and ordinary demand models.

2.1 Inverse demand models

In the inverse demand model supply is assumed determined by exogenous factors and demand is built on the causality where quantity and income explain price. The demand function is deduced on the basis of consumer preferences and economic possibilities. The deduction can be made by the use of a LaGrange optimisation and include more computable assumptions. If these assumptions hold, the aggregated demand function can in an unambiguous way be deducted from individual preferences and economic possibilities. In this case the model is theoretically consistent. If the assumptions do not hold, the aggregated demand function cannot be deducted from individual preferences and economic possibilities, and the model is theoretically inconsistent. The assumptions are adding-up, homogeneity and symmetry. In econometric estimations it is necessary to know these assumptions, since they allow the possibility to assess whether a model is theoretically consistent, and therefore based on microeconomic theory. The assessment can be done through testing assumptions on estimation results. In the inverse demand model the behavioural relations are scale and price flexibilities, where they are given in percent. Definitions are:

> *Scale flexibility*: percentage change in the marginal value of a good, whose buyers' aggregate consumption of goods increases by one percent. Given the adding-up assumption, aggregate consumption equates income. Provided that the flexibility is greater than –1 the good is a luxury, and provided that it is less than –1 the good is a necessity. For further interpretation see Eales and Unnevehr (1994).
>
> *Price flexibility*: percentage change in price of a good, as demand increases by one percent. Own price flexibility describes the percentage change in price of a

good, where the demand for exactly that good increases by one percent. Provided that the flexibility is greater than –1, the price is inflexible. If the flexibility is less than –1, the price is flexible. Two types of price flexibilities exist. The normal, uncompensated price flexibility contains both the direct quantity induced price effect, and the indirect quantity induced price effect, caused through changes in total expenditure. The compensated price flexibility only contains the quantity induced price effect.

Behavioural parameters are deduced from different forms of the inverse demand model. Written as a simple, static model for a closed economy with many goods, functional forms applied in the literature on EU seafood markets are given in equation 1-4.

Linear: (1) $p_i = \alpha_{0+}\alpha_i m + \sum_j \alpha_{ij} q_j$

Logarithmic: (2)

$$\ln(p_i) = \alpha_{0+}\alpha_i \ln(m) + \sum_j \alpha_{ij} \ln(q_j)$$

Rotterdam: (3)

$$w_i \ln\left(\frac{p_i}{m}\right) = \alpha_{0+}\alpha_i \ln(Q) + \sum_j \alpha_{ij} \ln(q_j)$$

Equation (4)

$$w_i = \alpha_{0+}\left(\alpha_{i+\mu_1} w_i\right)\ln(Q) + \sum_j \left(\alpha_{ij} + \mu_2 w_i\left(\delta_{ij} - w_j\right)\right)\ln(q_j)$$

Where: p_i	=	Price on good i.
q_j	=	Quantity of good j.
m	=	Revenue.
w_i	=	$(p_i q_i)/m$ = Market share of good i.
ln (Q)	=	$\sum_j w_j \ln(q_j)$ = Quantity index.
α_o	=	Intercept.
α_i	=	Coefficient of scale effect.
α_{ij}	=	Coefficient of quantity effect.

μ	=	Transformation coefficient.
δ_{ij}	=	Kroneckers delta.

In the logarithmic model the variables are given in common or natural form. The Rotterdam form is named after the home place of the two authors Barten and Bettendorf.

The functional forms in equation 1-4 are written in rank of increasing complexity. In all four models a price expression on the left side of the equation is per definition explained by expressions of income and quantity on the right side. Equations 1 and 2 are simple forms, where variables are given in linear and logarithmic forms. Equations 3 and 4 are extended forms, where the price expression include market shares The rationale is that quantity explains market share and in some cases price, rather than prices alone, because quantity changes the influence on market shares. Equation 3 is a special case of equation 4, where both transformation coefficients are 1.

Rationales for the single forms are mentioned below.

Linear form: the price is explained as a linear function of revenue and quantity and the model is simple and easy to estimate. Provided that the homogeneity and symmetry assumption holds, the model can be theoretically consistent. This is not tested

Logarithmic form: the price logarithm is explained as a function of the revenue logarithm and the quantity logarithm and the model is simple and easy to estimate. Moreover the interpretation of the model is easy, while scale and price flexibilities are constants. Finally after the introduction in USA of Bell (1960), the model is the most frequently used on the seafood market, including EU seafood markets. Provided that the homogeneity and symmetry assumption holds, the model can be theoretically consistent. This is not tested

Rotterdam form: the market share and the price logarithm in relation to revenue is explained as the logarithm of total quantity of all goods and the quantity logarithm of the single goods. The total quantity of all goods can be computed by use of a quantity index and can, in a model without savings, be replaced by income. All variables in the model can be computed on the basis of known numbers. Therefore the model is relatively easy to estimate. Provided that the homogeneity and symmetry assumption holds, the model can be theoretically consistent. Barten and Bettendorf (1989) perform a test and find that their model is theoretically consistent.

Generalised form: is a generalised version of equation 3,where μ_1 and μ_2 is 1. The model is estimated through a nesting procedure with different values of the transformation parameters. Provided that the homogeneity and symmetry assumption holds, the model can be theoretically consistent. This is not tested.

Choice of these functional forms in the analysis of given markets have to be based on both theoretically consistency (reliability of the adding-up, homogeneity and symmetry assumptions) and statistical fit (considerable explanation power, relevance of included variables and expected signs).

2.2 Ordinary demand models

In the ordinary demand model supply is assumed to be determined by exogenous factors and demand is built on the causality where price and income explain quantity. The ordinary demand function is deduced on the basis of consumer preferences and economic possibilities after the same principles as in the inverse demand model. Therefore the ordinary demand model is theoretically consistent only when the adding-up, homogeneity and symmetry assumptions hold. In the ordinary demand model the behavioural relations are income and price elasticises. These relations are named income and price elasticities when they are given in percent. Definitions are:

Income elasticity: percentage change in the demand for a good, as the buyers' income increases by one percent. Provided that the elasticity is greater than 1 the good is a luxury, provided that it is less than 1 and greater than 0 the good is a necessity, and provided that it is less than 0 the good is inferior.

The income elasticity plays the same role in the ordinary model as the scale flexibility plays in the inverse, as both numbers are used in the interpretation of income changes. The income elasticity and the scale flexibility are not comparable, but both are used to assess whether a good is luxury, necessary or inferior.

Price elasticity: percentage change in the demand after a good, as the price increases by one percent. Own price elasticity describes the percentage change in quantity, where the price of exactly that good increases by one percent. Provided that the elasticity is less than –1 the price is elastic, provided that the elasticity is 0 the price is neutral elastic, and provided that the elasticity is greater than –1, the price is inelastic. Two types of price elasticities exist. The normal, uncompensated price elasticity contains both the direct price induced demand effect, and the indirect price induced quantity effect, caused through changes in purchasing power. The compensated price elasticity contains only the price induced demand effect.

The price elasticity plays the same role in the ordinary model as the price flexibility plays in the inverse, as both numbers are used to describe the interaction between demand and price. Theoretically, own price elasticity and own price flexibility is directly comparable, as the elasticity can be computed as the inverse flexibility and vice versa. Practically however, it is not that simple, as Houck (1965) shows that the inverse elasticity will always overestimate own price flexibility. Cross price elasticity and cross price flexibility are not comparable in the same way. Both numbers give the opportunity to assess whether two goods are substitutes or complements, and to which degree.

Behavioural parameters are deduced from different forms of the ordinary demand model. Written as a simple, static model for a closed economy with many goods, functional forms applied in the literature on EU seafood markets are given in equation 5-9.

Linear: (5) $q_i = \beta_0 + \beta_i I + \sum_j \beta_{ij} p_j$

Linear/log: (6)

$$q_i = \beta_0 + \beta_i \ln(I) + \sum_j \beta_{ij} \ln(p_j)$$

Logarithmic: (7) $\ln(q_i) = \beta_0 + \beta_i \ln(I) + \sum_j \beta_{ij} \ln(p_j)$

Box-Cox: (8)

$$\frac{q_i^{\mu}-1}{\mu}=\beta_0+\beta_i\frac{I^{\mu}-1}{\mu}+\sum_j\beta_{ij}\frac{p_j^{\mu}-1}{\mu}$$

AIDS: (9) $$w_i=\beta_0+\beta_i\ln(I)+\sum_j\beta_{ij}\ln(p_j)$$

Where: I = Income.

β_0 = Intercept.

β_i = Coefficient of income effect.

β_{ij} = Coefficient of price effect.

The Box/Cox form is named after the two authors, the AIDS form is short for Almost Ideal Demand System and the rest of the signatures are given below equation 4.

The functional forms in equations 5-9 are written in rank of increasing complexity. In all five models a quantity expression on the left side of the equation is per definition explained by expressions of income and price on the right side. Equations 5-7 are simple forms, where variables are given in linear and logarithmic forms. Equations 5-7 are special cases of equation 8, where the transformation coefficient μ is of different values in the three equations, e.g. μ =1 in equation 5. Finally equation 9 is an extended form, where the price expression on the left side is given as a market share. The rationale for this is just as in the inverse forms in equations 3 and 4, that prices explain market shares, as changes in the relative price cause market shares to change.

The rationale for the single ordinary functional forms is mentioned below, just as for the inverse forms.

Linear form: the demand is explained as a linear function of income and price and the model is simple and easy to estimate. Provided that the homogeneity and symmetry assumption holds, the model can be theoretically consistent. This is not tested.

Linear/logarithmic form: the demand is explained as a function of income logarithm and price logarithm and the model is simple and easy to estimate. Provided that the homogeneity and symmetry assumption holds, the model can be theoretically consistent. This is not tested.

Logarithmic form: the demand logarithm is explained as a function of income logarithm and the price logarithm and the model is simple and easy to estimate. Moreover the interpretation of the model is easy, while income and price elasticities are constants. Therefore the model is broadly applied on EU seafood markets. Provided that the homogeneity and symmetry assumption holds, the model can be theoretically consistent. This is not tested

Box-Cox form: is a generalised version of equations 5-7 for different values of the transformation coefficient μ. The model is estimated through a nesting procedure with different values of the transformation parameter μ. Provided that the homogeneity and symmetry assumption holds, the model can be theoretically consistent. This is tested.

AIDS form: the market share is explained as a function of the income logarithm and the price logarithm and the model is simple and easy to estimate. Provided that the homogeneity and symmetry assumption holds, the model can be theoretically consistent. Burton and Young (1992) perform a test and find that their model is theoretically consistent.

Choice of these functional forms in the analysis of given markets have to be based on both theoretically consistency (reliability of the adding-up, homogeneity and symmetry assumptions) and statistical fit (considerable explanation power, relevance of included variables and expected signs).

2.3 Improvements

The above ordinary and inverse demand models are written as a static model for closed economies. These models are built on more assumptions. Among others, that the adjustment processes between different states are not explained within the models, that economies are closed, that there is competition on markets, that there are no interactions between seafood markets and other markets, and that supply is given by exogenous factors.

In the static model the behavioural parameters are identified on the basis of the relationship between equilibrium at two different occasions, without the assessment of the adjustment process between these two occasions. In a dynamic model the adjustment process and the time of the adjustment process are assessed. Moreover it is assessed how the adjustment process affects the estimation of the behavioural parameters.

In closed economy models only one market is described, whereby indirectly assuming that prices are formed without interactions with price formations in other economies. On seafood markets this is an unrealistic assumption, as foreign trade is substantial. For instance price flexibilities estimated by the use of closed economy models will be underestimated in economies with substantial foreign seafood trade on international delineated markets. The reason is that the market in the closed economy model is constrained to just the market in the closed economy. In a model for an open economy price formation takes place on the whole international delineated market.

In a partial economic model the equilibrium is described in a specified part of an economy, for example the seafood market, without taking interactions between the seafood market and other parts of the economy into account. In a macroeconomic model and a computable generalised equilibrium model all parts of the economy can be described, maybe with emphasis on a specific part of the economy, e.g. the seafood market.

In the above models perfect competition is implicitly assumed. This is not always the case on EU seafood markets. For example, Norwegian salmon suppliers have dominated the French salmon market for years, according to DeVorets and Salvanes (1993) and Steen (1995). In a model with monopoly, the supplier adjusts prices after the buyer's willingness to pay. Thereby the monopolist's supply and buyer's demand is identical.

In the above demand models the equilibrium on a given market is decided where supply equates demand, given exogenous supply. The assumption is not always realistic. In the literature therefore more models with looser assumptions have been developed.

Choice of improved model may be based on theoretically consistency, statistical fit and knowledge of market delineation and trade patterns.

2.4 Model assessment

Choice of ordinary or inverse demand model may be based on the realism of causality. In the case of food, the causality from demand changes to price is found more realistic than vice versa, as demand for food seems more determined by human needs, regardless of the price, than the demand for other goods. In the case of seafood in particular, the causality from demand changes to price is found more realistic than vice versa. This is because seafood is food and that demand is given by a marked exogenous supply, which is determined by circumstances such as bio-economy, weather, fishery management etc.

In the literature ordinary demand models are used to forecast demand and inverse demand models are used to forecast price. In a part of this literature both models are used on the same data set and thereby forecast properties are tested. Burton (1992) finds that the inverse demand model forecasts price of wet fish in UK significantly better than the ordinary model forecasts demand for wet fish in UK. Eales et. al. (1997) reach the same conclusion regarding Japanese fish markets.

3. Data

Time series data include 25 species or groups of species in six product forms (fresh, frozen, frozen fillets, smoked, salted and dried). The species is grouped on the basis of consumers expected assessment of characteristics:

Codfish:	Cod, haddock, saithe, whiting, hake and redfish.
Flatfish:	Plaice, sole, turbot, anglerfish and ray.

Pelagic fish: Herring, mackerel, sardine, anchovies and tuna.

Salmon: Salmon.

Crustaceans and mollusc: Crustaceans, molluscs, shell-fish and lobster.

Data are from 8 EU countries and all EU, include primarily the period 1980-96, are stated in months, quarters and years and are from ex-vessel, import, wholesale and retail markets.

Data from the ex-vessel market are based on catch and landing statistics in single EU countries. While data are used for control purposes, they are excellent in many countries. This is the case in countries fishing in the ICES area (the Central and North Eastern part of the Atlantic with the North Sea and the Baltic Sea included), but not in countries fishing in the CFCM area (The Mediterranean Sea). Data from the ex-vessel market are based on settlements of accounts for fish trade in the first level.

Data from the import market are broadly applied, because commodity groups are detailed and standardised among all EU countries (built on the Harmonized System and the Standard Industrial Trade Classification). Data from the import market are the only standardised fisheries statistics, which cover all EU countries.

Data from the wholesale market are typically formed as a part of a bigger geographic market; for example trade on a fish auction. Therefore in the interpretation it has to be assumed, that this trade is representative of the whole market. Detailed statistics exist from more fish auctions.

Data from the retail market are limited. The only statistics known is “Household Fish Consumption in Great Britain”, published by Sea Fish Industry Authority in Scotland. These statistics reveal time series on UK consumers’ buying of fish. The statistics are based on questionnaires.

Quantities on all markets are stated in tonnes and include all or part of the analysed market. Prices in most surveys are calculated as a mean of revenue. Prices in other surveys are from single fish auctions, because of lack of statistics. Prices are sometimes without inflation. Income and total revenue are calculated on basis of Gross Domestic Product. Data on other variables are applied ad-hoc on the basis of existing possibilities.

4. Empirical Results

The below assessments are built on two basic assumptions, product homogeneity and that behaviour does not differ significantly between EU countries.

4.1 Codfish

Good type

Scale flexibilities for codfish is estimated to be[–1.21; 0.89] and income elasticities to be [0.17; 3.12]. Scale flexibilities are approximately –1 or greater, i.e. codfish is a luxury. Some income elasticities are larger than –1 and others are less, i.e. some surveys assess codfish as luxuries others as necessities.

Scale flexibilities for cod is estimated to be [–1.13; -1.00] and for haddock to be –0.82, whiting [-1.15; -0.88], redfish –0.77 and hake [-1.21; 0.89]. Scale flexibilities for all codfish approximates –1, however hake in Italy excluded. Income elasticities for whitefish is estimated to be [0.17; 1.04], for cod to be [1.86; 3.12] and for haddock to be [0.54; 2.09]. Income elasticities for whitefish is approximately less than 1, for cod greater than 1 and for haddock both greater and less than 1. These results indicate that cod, haddock, whiting and redfish approximate homothetic preferences, where whitefish and hake mainly are necessities. The reason for whitefish being a necessity and the single species approximating homothetic preferences can be that whitefish make up a larger part of a delineated market than the single species.

Young (1984) and Millán and Aldaz (1998) assess the difference between fresh and frozen codfish concerning good type. Young (1984) estimates the income elasticity for fresh and frozen cod in UK to be 1.97 and 1.86 respectively, and Millán and Aldaz (1998) estimate the scale flexibility for fresh and frozen hake in Spain to be –0.94

and – 1.21 respectively. The results indicate that fresh codfish are more luxury than frozen codfish.

Scale flexibilities for codfish in Belgium is estimated to be [-1.15; -0.77] and in Spain to be [-1.21; -0.79]. Income elasticities in UK estimated to be [0.17; 2.09]. The results indicate that codfish approximates homothetic preferences in both Belgium and Spain, where codfish in UK is assessed as both luxuries and necessities, however results may be interpreted with caution, as two different models are used.

Scale flexibilities for codfish are on the ex-vessel market estimated to be [-1.21; -0.77]. Income elasticities are on the retail market estimated to be [0.17; 2.09]. Scale flexibilities on the ex-vessel market are approximately –1, i.e. consumers have homothetic preferences. The income elasticities on the retail market indicate that codfish is assessed as both luxuries and necessities. Therefore on the ex-vessel market variation in results is limited, but on the retail market larger. This can be explained by the fact that product differentiation increase as the good goes through the distribution chain.

Codfish as a whole may be characterised as a good with almost homothetic preferences.

Price sensitivity

Own price flexibilities for codfish are estimated to be in the interval [–0.48; 0.00] (-2.78; -0.05)[1], i.e. codfish prices are very inflexible and percentage changes in demand affect prices considerable less.

Own price flexibilities for cod are estimated to be in the interval [–0.34; 0] and for haddock [-0.45; -0.02], saithe [-0.27; -0.02], whiting [-0.38; -0.13], redfish [-0.09; -0.02], hake [-0.36; -0.10] and for whitefish [-0.48; -0.26]. Therefore own price flexibilities are inflexible for all species. However the price flexibility for the whitefish group is more flexible than for the single species. This result can be interpreted by the fact that the whitefish market, consisting of cod, haddock, saithe and hake, is larger than the single species markets. Therefore prices formation for single species are more inflexible. This can only be the case on a delineated market, as relative changes in demand on a part of the delineated market, only have a marginal effect on prices on

[1] Angular parenthesis in sections concerning price sensitivity state own price flexibilities and soft parenthesis state inverted own price elasticity.

the delineated market. The reason is that a relative change in demand on most of the delineated market causes larger price changes on the delineated market.

Ioannidis and Lantz (1994) examine the difference between price flexibility for fresh and frozen cod on the French market. Price flexibilities are estimated to be –0.21 and –0.30 respectively, i.e. the fresh cod price is a little more flexible than the frozen cod price.

Own price flexibilities for codfish is in UK estimated to be [–0.48; -0.04], France [-0.27; -0.02], Belgium [-0.13; -0.09], Germany [-0.02; 0], Denmark [-0.14; -0.11] and Spain [-0.38; -0.10]. The estimations indicate that the own price flexibility is larger on the big markets in UK and Spain, a little smaller in France and the smallest on the small markets in Denmark and Belgium. The explanation for this result can be that markets are delineated and percentage demand changes on big markets thereby have the largest effect on prices on the delineated market. The inflexible German prices can be caused by the extensive import, causing this market to operate more on an international delineated frozen market.

Ioannidis and Lantz (1994) estimate price flexibilities for fresh cod in UK to be –0.98 on the basis of monthly periods and to be –0.21 on the basis of quarters. That is, price flexibilities are larger in the short than in the long run and demand changes of fresh cod affect prices more in the short than in the long run. Therefore after exogenous changes, price will move towards stable long run equilibrium.

It can be concluded that codfish prices are very inflexible, with own price flexibilities from –0.5 to 0. Moreover it can be concluded:

- That significant difference between price flexibilities of different codfish species cannot be shown.

- That the whitefish price flexibility is larger than for the single codfish species, that is, codfish markets may be delineated.

- That price flexibilities is larger on the big markets in UK and Spain, smaller on the French market and smallest on the small markets in Denmark and Belgium. This indicate that markets may be delineated.

- That price will move towards stable long run equilibrium after an exogenous shock.

4.2 Flatfish

Good type

Scale flexibilities for flatfish are estimated to be in the interval [–1.14; 0.86] and the income elasticities to be in the interval [0.59; 0.98]. Scale flexibilities are, exclusively 0.86 for sole in Italy, approximately –1, i.e. flatfish have homothetic preferences. Income elasticities indicate that plaice on the retail market in UK is a necessity. The income elasticity is larger for fresh than for frozen plaice, i.e. fresh plaice in UK is a luxury more than frozen plaice.

Price sensitivity

Own price flexibilities for flatfish are estimated to be in the interval [–0.57; -0.07] (-4.76; -0.36), i.e. flatfish prices are as is the case for codfish prices inflexible and percentage changes in demand affect prices considerable less.

Own price flexibilities for sole are estimated to be in the interval [–0.57; -0.11] and for plaice [-0.45; -0.02], turbot [-0.35; -0.30], rays –0.37 and anglerfish [-0.13; -0.07]. Own price flexibilities are estimated in a larger interval for sole than for other flatfish species and the own price flexibilities for turbot and rays are a little larger than for plaice. The own price flexibilities for anglerfish are smaller than for plaice. The large price flexibilities for turbot and rays can be explained by a weak delineation with other seafood markets, as demand changes on a little market for separate species cause considerable percentage changes on small separate markets. The smaller price flexibilities for plaice particularly but also for sole, can be caused by strong delineation with codfish markets. On this basis it cannot be rejected that sole and plaice form a part of a larger delineated market consisting of these species, and among others also codfish.

Own price flexibilities for flatfish in UK are estimated to be in the interval [-0.30; -0.20] and in France [-0.43; -0.27], Netherlands [-0.57; -0.12] and Belgium [-0.37; -0.11]. Price flexibilities for the Netherlands seem to be estimated in a larger interval than for other countries, which can be explained by the length of the estimation period. Thereby Jørgensen et. al. (1989) estimate price flexibilities for sole in the Netherlands to be –0.57 and –0.19 for one month with lags and for one month respectively, i.e. sole prices are more flexible in the long run than in the short run. Jørgensen et. al. (1991) obtain the same results for plaice in the Netherlands. This result is not compatible with a priori expectations that price will move towards equilibrium in the long run, but can be caused by sluggishness in the price formation. Price flexibilities for Belgium are less than for the other countries, which maybe can be explained by strongly delineated markets. Beyond this, price flexibilities are without significant differences between countries.

4.3 Pelagic fish

Good type

Scale flexibilities for pelagic fish are estimated to be in the interval [–1.78; -1.08] and the income elasticities in the interval [-5.21; 0.06]. Scale flexibilities are estimated for tuna, anchovies and sardine in Spain and these three species are necessities there. Income elasticities are estimated for fat fish (herring and mackerel) and smoked mackerel in UK. Results indicate that all pelagic fish species are necessities, smoked herring excluded as an inferior good. That is, if income increases consumers prefer to buy something better than smoked mackerel. Moreover results indicate that tuna, anchovies and sardine are more luxury goods than herring, mackerel and smoked mackerel.

Price sensitivity

Own price flexibilities for pelagic fish are estimated to be in the interval [–0.68; -0.06] (-0.65; -0.40), i.e. pelagic fish prices are, as is the case for codfish prices, inflexible. However the interval for pelagic fish is broader than for other species, as the price flexibility for anchovies in Spain is large. The explanation of this can be, that anchovies prices only to a very limited extent are formed on delineated markets.

Own price flexibilities for fat fish are estimated to be –0.49 and for herring to be [-0.25; -0.06], mackerel [-0.13], anchovies [–0.68], sardine [-0.34] and tuna [-0.30]. Own price flexibilities are largest for anchovies, smaller for fat fish, sardine and tuna and the smallest for herring and mackerel. The relatively small tuna and sardine price flexibilities can be caused by some market delineation between those markets and among others codfish, plaice and sole markets. The reason why the price flexibility for fat fish is larger than for herring and mackerel separated can be that the two markets are delineated.

Smit (1988) examines the difference between price flexibilities for fresh and salted herring in the Netherlands. Price flexibilities are estimated to be –0.25 and –0.18 respectively, i.e. fresh herring prices are more flexible than salted herring prices.

Own price flexibilities for pelagic fish in UK are estimated to be in the interval [–0.49; -0.06], Netherlands [-0.25; -0.18] and Spain [-0.68; -0.30]. Results indicate that own price flexibilities are larger on the big markets in UK and Spain than on the smaller market in the Netherlands. However results can indicate that surveys are performed on different aggregation levels or on markets with different market delineation. Therefore conclusions concerning price flexibilities are not unambiguous.

Smit (1988) shows a structural change on the market for salted herring before and after the ban of herring fisheries in the North Sea in 1977-81. Price flexibilities are estimated to be –0.63 and –0.18 on the basis of data from 1951-77 and 1980-86 respectively. That is, the price changes from being flexible to demand changes before the ban, to being less flexible afterwards. The change following the ban has caused the salted herring market to disappear and the remaining herring fishery has therefore changed towards a mass fishery for mackerel or horse mackerel and the price as a result has became less flexible. The conclusion is that the ban of herring fisheries has been too restrictive, as the market disappearance has caused permanent negative economic consequences for the fishing industry. A less restrictive catch restriction could have reduced the risk of market disappearance and the negative short run economic consequences could simultaneously have been reduced as prices would rise, according to the own price flexibility on –0.63.

4.4 Salmon

Good type

Income elasticities for salmon are estimated to be in the interval (0.24; 13.85). Scale flexibilities are not estimated. Salmon is assessed to be a luxury good in all cases except the newest one, as Asche et. al. (1997) estimate the income elasticity for fresh and frozen salmon in EU for 1981-92 to be 0.24 and 0.45 respectively. Thereby it is indicated that salmon can be a necessity. Results can be interpreted to show that farmed salmon has spread on EU markets and salmon prices have decreased so much, that the consumers do not percept farmed salmon as a luxury good. Therefore a structural change in consumer preferences can have occurred.

Moreover Asche et. al. (1997) found that frozen salmon is a luxury good more than fresh salmon. This is not in harmony with a priori expectations, but maybe it can be explained by the fact that fresh salmon transportation from Norway to, among others the French market takes time. Thereby it is not certain whether the salmon is fully fresh at time of sale.

Price sensitivity

Own price flexibilities for salmon are estimated to be in the interval (-1.61; -0.20), all by the use of ordinary demand models. Therefore salmon prices are less flexible than codfish and flatfish prices, when comparisons are made between results obtained by the use of ordinary demand models. The reason for this can be the international delineation between salmon markets.

Asche et. al. (1997) examine differences between price flexibilities for fresh and frozen salmon in EU, as they estimate the flexibility to be –0.27 and –0.39 respectively. That is, the price flexibility for frozen salmon is larger than for fresh salmon.

Own price flexibilities for salmon in EU is estimated to be (–0.56; -0.24) and in France (-1.61; -0.33), Germany (-0.43; -0.20), Spain (-0.95; -0.56) and Italy (-1.52; -0.79). German results indicate that the salmon prices, exactly as codfish prices, are almost totally inflexible. Moreover results indicate that price flexibilities are largest on markets in France, Spain and Italy and lesser in all EU. Results are contrary to the a priori expectations that price flexibilities are larger, the larger part of an international market considered, as price flexibilities for all EU are lesser than for France, Italy and Spain.

Maybe results can be explained by different estimation periods. Mazany and Holmefjord (1988) find that prices in the short run are more flexible than in the long run on both French and German markets. Bjørndal et. al. (1992a) and Bjørndal et al. (1994) reach the same conclusions on both Spanish and Italian markets. Therefore demand changes affect prices more in the short run than in the long run and prices will move towards stable long run equilibrium after exogenous shocks. Provided that results from different countries estimated by the use of different periods can be compared, the above conclusions are also reached.

Model specification affect obtained results, as only ordinary demand models are used. Therefore price flexibilities are overestimated, according to section 2.2. However the problem is met as inverse price elasticities for salmon are only compared with inverse price elasticities for other fish species.

4.5 Crustaceans and molluscs

Good type

Scale flexibilities for crustaceans and mollusc in Spain are estimated to be –0.06 and –0.16 respectively. Income elasticity for crustaceans in EU is estimated to be 1.66. Results indicate that crustaceans and molluscs are luxury goods.

Price sensitivity

Own price flexibilities for crustaceans and molluscs are estimated to be in the interval [–1.00; -0.19] (-2.86; -0.48). Therefore crustaceans and mollusc prices seem to be more flexible than fish prices. This can be caused by the fact that crustaceans and molluscs are more special or more exotic than fish and therefore prices are formed on separate markets.

Gilly et. al. (1984) estimate price flexibilities for small and big lobster in France to be –0.45 and –1.00 respectively. Therefore the big lobster price are more flexible than the small lobster price and it is thereby indicated that prices of the two sizes are formed on different markets.

The difference between price flexibilities in the short and long run is assessed for shellfish in EU by the use of an ordinary demand model of Guillotreau et. al. (1998). Price flexibilities for estimation periods of years and months are estimated to be –0.49 and –2.86 respectively. Therefore demand changes affect prices more in the short run than in the long run and prices will move towards stable long run equilibrium after exogenous shocks.

4.6 Seafood

Above good type and price sensitivity are assessed for groups of seafood species. Below an overview of the EU seafood market is discussed, partly by assessment of seafood as an aggregated good and partly by summing results obtained in sections 4.1 – 4.5.

Good type

Burton and Young (1992) estimate income elasticities for fish in UK to be 0.76, i.e. fish as one good is a necessity. However between species significant differences are seen. Salmon, crustaceans and molluscs are luxuries and consumers have approximate homothetic preferences for codfish. Flatfish is mainly a necessity, but consumers also have approximate homothetic preferences for flatfish. Pelagic fish is a necessity, although smoked mackerel is inferior. Therefore single seafood species are percepted as luxuries, necessities and inferior and also as goods with homothetic preferences.

Price sensitivity

Own price flexibilities for seafood as one good are estimated to be in the interval (-4.00; -0.36). Therefore seafood as one good seems very flexible compared with the single species results. However all results are estimated by the use of the ordinary demand model and the own price flexibilities are thereby overestimated, according to section 2.2.

Price flexibilities for seafood as one good and for single species can be compared only by results obtained by use of the ordinary demand model. Own price flexibilities in the ordinary demand model are for codfish estimated to be in the interval (-2.78; -0.05) and for flatfish (-4.76; -0.05), pelagic fish (-0.65; -0.40), salmon (-1.61; -0.20) and crustaceans/molluscs (-2.86; -0.48). Except for the large flatfish price flexibility (sole in France), the price flexibilities for seafood as one good are larger than for the single species. The reason can be that price flexibilities are larger, the larger part of a delineated market there is considered.

Guillotreau et. al. (1998) assess differences between price flexibilities for fresh and frozen fish in EU, as price flexibilities are estimated to be –0.46 and –0.95 respectively. Therefore the price flexibilities are larger for fresh fish than for frozen fish. Conversely, Asche et. al. (1997) compare the price flexibilities for fresh and frozen salmon in EU and find that the frozen salmon price flexibility is largest. Therefore results are not unambiguous.

Own price flexibilities in ordinary demand models are in EU estimated to be (–4.00; -0.46), in UK to be (-1.69; -1.49) and in France to be (-2.67; -0.36). Results indicate that price flexibilities are largest on the big EU market and smaller on the smaller market in UK and France. Corresponding results are obtained for codfish where price flexibilities are largest on the large markets in UK and Spain, smaller in France and smallest on the small markets in Denmark and Belgium. These results can only be obtained on delineated markets.

Burton and Young (1992) estimate price flexibilities for seafood in UK as one good to be –1.69 on the basis of quarters and to be –1.49 on the basis of years. Therefore price flexibilities are larger in the short than in the long run. Guillotreau et. al. (1994) and Peridy et. al. (1998) obtain the same results for seafood as one good in France and EU respectively. Ioannidis and Lantz (1994) obtain the same result for fresh cod in France and Mazany and Holmefjord (1988), Bjørndal et. al. (1992a) and Bjørndal et al. (1994) obtain the same results for salmon on the French, German, Spanish and Italian market respectively. Therefore demand changes affect prices more in the short run than in the long run and prices will move towards stable long run equilibrium after exogenous chocks.

Assessments are carried out given that the choice of model does not affect results. This can be the case in more ways. Functional forms can affect results. In the inverse model price flexibilities are by the use of the logarithmic form estimated to be in the interval [-0.49; 0], by use of the Rotterdam form [-0.37; -0.09] and by use of the generalised form in equation 4 [-0.68; -0.10]. The price seems a little more flexible in the generalised form than in the other two, presumably caused by special circumstances on the Spanish market. Therefore significant differences between price flexibilities estimated in the three models cannot be shown.

In the ordinary model price flexibilities are by the use of the logarithmic form estimated to be in the interval (-4.76; -0.03) and by use of the AIDS form in the interval (-1.69; -0.24). The price seems more flexible and the results more spread by the use of the logarithmic form than by the use of the AIDS form. The reason for this can be that the logarithmic form is estimated considerable more times than the AIDS form or that the AIDS form is safer in the estimation. Therefore it cannot be rejected that the AIDS form is better than the logarithmic form.

Choice of the static or dynamic model can affect results. Burton and Young (1992) estimate price flexibilities for fish in UK to be –1.49 and –1.52 by the use of static and dynamic model respectively. Thereby choice of the static or dynamic model does not seem to affect results. This result is not consistent with a priori expectations and surveys confirming this result are not known.

Finally choices of the inverse or ordinary model affect results considerable, according to section 2. Thereby price flexibilities in the inverse model are estimated to be in the interval [-1.00; 0] and in the ordinary model in the interval (-4.76; -0.03). This result indicates that the price in the ordinary model is estimated as more flexible than in the inverse model. The result corresponds to Houck (1965), as he shows that inverse own price elasticities always overestimate price flexibilities.

In other words the choice of model does affect results. The choice of the ordinary or inverse model is decisive in determining whether prices are estimated as flexible or inflexible. On the basis of empirical estimations on EU seafood markets it cannot be assessed which of the two models is the best. The choice may be based on theoretical considerations about causality and on tests on seafood markets elsewhere. These considerations are discussed in section 2.4, where it is concluded that the inverse model is most realistic on seafood markets. The choice of functional form, choice of static or dynamic model and choice of econometric method can also affect results.

Interpretations in this section are built on two basic assumptions. Partly product homogeneity and partly that behaviour does not differ significantly between EU countries. These assumptions do not necessarily hold. The product homogeneity assumption is presumed to hold in most cases as estimation is done on the detailed species level. The assumption that behaviour does not differ significant between EU countries cannot be assessed, as known surveys do not make simultaneous estimations on more markets.

5. Discussion and Perspectives

The purpose of the present paper has been to create a preliminary base from which an Economic Model of EU Seafood Demand, to evaluate changes in fisheries policy, can be developed. For this purpose existing and known surveys of the economic behaviour in the Fishing Industry have been described.

Knowledge of the economic behaviour will be applied in the development of a model, which has to include all EU countries, and explain price formation on seafood at the ex-vessel level endogenously. The model has to be built as a neo-classical partial equilibrium model, which has to fit with traditional microeconomic theory.

The model will be developed in three steps. First studies of market delineation are reviewed with the purpose of defining boundaries in relation to species and countries.

Thereafter input-output tables will be constructed, using ex-vessel (and aquaculture production) and foreign trade statistics. Only species for consumption and subject to TAC under the Common Fisheries Policy are examined. Data needs are analysed and available and existing data is collected. The input-output table with quantities and values will be constructed in four stages over a period of time for:

1. Seafood as one good in EU.

2. Seafood as one good, disaggregated by member states.

3. 5-6 species groups, disaggregated by member states.

4. All species subject to TAC in the common fisheries policy, disaggregated by member states.

Finally the input-output tables will be used to estimate the economic model using econometric methods and microeconomic theory.

The models will then be applied as neo-classical partial equilibrium models, to evaluate changes in fisheries policies, i.e. in conservation, market and trade policies or the models will be applied for assessment of coherence between these policies (this will be decided at a later date). The model will be applied on four levels in accordance with the input-output tables. Finally an attempt will be made to develop a closed computable generalised equilibrium model to analyse the role of the EU seafood sector in the global economy.

6. Conclusion

Demand studies are used to assess behaviour on EU seafood markets. However heterogeneity of the models according to both form and analysed market imply that results have to be used with caution.

The choice of ordinary or inverse model is decisive in determining whether prices are estimated as flexible or inflexible. Therefore the choice may be based on theoretical considerations about causality and on empirical tests of forecast properties. It is argued that the inverse model outperforms the ordinary model on seafood markets, as seafood is food which has to satisfy human needs, and as quantities are given by a marked exogenous supply, which is determined by bio-economy, weather, fishery management etc. Moreover a test of forecast properties show that the inverse demand model forecasts price significantly better than the ordinary model forecast demand. Finally, price flexibilities are estimated to be in the intervals [-1.00; 0] and (-4.76; -0.03) in inverse and ordinary models respectively, i.e. results are considerably less spread in inverse than in ordinary models.

Using the inverse demand model prices are found to be inflexible as quantities are changed. For example, a 10% quantity reduction will cause a 0-10% price increase, 2.7% on average. However the size of price flexibilities depends on market delineation and aggregation level. Using both ordinary and inverse demand models seafood as a whole and pelagic fish are found to be necessary goods, salmon a luxury good, and smoked mackerel an inferior good. Groundfish is a good with homothetic preferences.

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