SNF Working Paper No. 37/05

Demand structure for fish

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SNF Project No. 5256: "SIP Resource Management"
The project is financed by The Research Council of Norway

INSTITUTE FOR RESEARCH IN ECONOMICS AND BUSINESS ADMINISTRATION

BERGEN, AUGUST 2005

ISSN 1503-2140

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ABSTRACT

During the last decades, there has been virtually an explosion in the number of studies of the demand structure for seafood markets. The most common approach is demand analysis, where demand equations are estimated either individually or in a system of demand equations. These studies of the demand structure focus on the price sensitivity of demand, on the degree of substitution between potentially competing products and on income/expenditure effects. However, as price information is often more available than quantity, there have been a number of market integration studies that primarily focus on the competition between different products. The purpose of this paper is to give a review of demand and market integration studies with respect to fish, focusing on the method used, the information that is obtained, and how this information varies with the approach used.

1. INTRODUCTION

Until the mid 1980s, the structure of the demand for seafood received little academic attention. During the last decades, there have been virtually an explosion in the number of studies of the demand structure for seafood markets. This is due to several factors including the expansion of the Exclusive Economic Zone to 200 miles and increased trade with seafood due to improved logistics and the expansion of aquaculture (Anderson, 2002; Asche, Bjørndal and Young, 2002). The most common approach is demand analysis, where demand equations are estimated either individually or in a system of demand equations. These studies of the demand structure focus on the price sensitivity of demand, on the degree of substitution between potentially competing products and on income/expenditure effects. However, as price information is often more available than quantity, there have been a number of market integration studies that primarily focus on the competition between different products.

The different studies are empirical and are of course in each case conducted on a specific data set. This gives, strictly speaking, information about the demand structure for some specific products or species in a specific market for the time period covered by the data set used. The purpose of this paper is to give a review of demand and market integration studies with respect to fish, focusing on the method used, the information that is obtained, and how this information varies with the approach used. That is, are there any patterns that become apparent when one looks at the results obtained in a number of demand studies of seafood markets? What can we say about the demand for fish in general or about the demand for specific groups of species or markets?

To present results from many different studies creates a number of problems that one should be aware of when comparing the results. In addition to the different markets and species studied, a number of different methods have also been used. Since the methods used affect the interpretation of the results, it is also important to be aware of the potential differences.

Moreover, measuring data at different market levels e.g., import or retail has important implications for interpretation of the results.

The different methods used for data measurement at different market levels make the results incomparable in a strict sense. Nevertheless, some comparisons are possible. In particular, one might observe whether the price responsiveness for fish is in a specific range, or whether this varies systematically with species, markets or measurement level for the data.

Some implications of economic theory for the magnitudes of the elasticities are worthwhile to note immediately. A demand elasticity of –1 is a focal point. A good with constant budget share and no substitutes will have an elasticity of –1, so that a 1% increase in the price will lead to a 1% reduction in the quantity demanded and vice versa. In particular for aggregated goods, the budget shares are relatively constant with few substitutes. This indicates that one should expect many demand elasticities to be close to –1. It is also of interest to note that the value of a market is at its highest when the demand elasticity is –1. If the supplied quantity increases above the level that gives a demand elasticity of –1, the value of the market will fall. Finally, the more elastic the demand for the good, the greater substitution possibilities there will be and therefore the keener the competition.

We will of course be limited to the markets that have been studied. This might unfortunately leave some big holes. In particular, few studies have been carried out on the demand for fish in developing countries. Moreover, we cannot hope to cover the substantial number of reports and working papers on the demand for seafood. In section 2 we provide a brief description of the approaches used in estimation. . In section 3 we discuss market integration studies and show to what extent demand analysis and market integration provides complementary information. In section 4, we will provide a review of a number of demand studies related to fish. The review will focus on own-price or demand elasticities. We will try to emphasise main trends, and not necessarily to discuss too many specific studies. While we do not give much attention to cross-price effects, these are also obviously important when considering demand structure, and the degree of competition will be commented on briefly. In section 5 we discuss the results form market integration studies before some concluding remarks are provided in section 6.

2. DEMAND ANALYSIS

In this section, the most common functional forms for demand system specification are presented and discussed. We start with single equation specifications, before we review the most common flexible functional forms; the Rotterdam system and the almost ideal demand system (AIDS).

The first empirical demand studies were mostly concerned with estimating elasticities and paid little attention to consumer theory (Deaton and Muellbauer, 1980b, p. 61). The researchers specified (mostly quantity dependent) single equation demand functions linear in the parameters, of which the double log was the most common specification. This specification is still common today. Letting q_{it} be the quantity consumed of good *i* at time *t*, p_{jt} the price of good *j* at time *t* and X_t the expenditure at time *t*, the equation to be estimated with this specification is

$$(1) \qquad \ln q_{it} = \alpha_i + \sum_j e_{ij} \ln p_{jt} + e_i \ln X_t$$

The advantage with this specification is that the estimated parameters can be interpreted as elasticities as $e_{ij} = \partial \ln q_{it} / \partial \ln p_{jt}$ (the own and cross price elasticities) and $e_i = \partial \ln q_{it} / \partial \ln X_t$ (the expenditure elasticity). The range of *j* varies, and typically includes commodities which are assumed to be closely associated with good *i*. The measure of expenditure X_t is typically a (often highly aggregated) measure of the consumer's income.

Economists had early discovered that dynamics might be important in consumer behaviour. The first explicit attempt to specify demand functions that distinguished between short- and long-run behaviour was, to the author's knowledge, Houthakker and Taylor's (1966) habit formation model. This model is based on the double log and may be written as

(2) $$\ln q_{it} = \alpha_i + c_i \ln q_{it-1} + \sum_j e_{ij} \ln p_{jt} + e_i \ln X_t .$$

The dynamics are introduced in the lagged consumption variable, q_{it-1}, which makes current consumption dependent on the previous period's consumption. The short-run elasticities are e_{ij} and e_i, and the long-run elasticities are found by setting $\ln q_i$ equal at all times, as implied by the notion of long-run equilibrium. The long run elasticities may then be computed from (2) as $\eta_{ij} = e_{ij}(1-c_i)^{-1}$ and $\eta_i = e_i(1-c_i)^{-1}$. To be consistent with utility maximisation, the parameter c_i must be between zero and one. This seems to hold in all empirical analyses.

During the 1970s, very dynamic models, mostly motivated by problems with persistent autocorrelation and bad forecasting abilities, appeared in the macro economic literature, particularly in connection with the consumption function. The work of Davidson *et al*. (1978) has left a major impact, not only on macroeconomic work, but on all empirical work in economics based on time series data, including demand analysis. The basic formulation is an autoregressive distributed lag model based on some functional form, usually a functional form linear in the logarithms of the variables. Based on a double log, this may be written as

(3) $$\ln q_{it} = \alpha_i + \sum_{k=1}^{r} c_{ik} \ln q_{it-k} + \sum_j \sum_{l=0}^{s} e_{ijl} \ln p_{jt-l} + \sum_{l=0}^{s} e_{il} \ln X_{t-l} .$$

The numbers of lags, *r* and *s*, is an empirical question. They are chosen large enough to account for all dynamics such that the resulting residual in the empirical specification is white noise.

There are both statistical and economic arguments for including lags in a model such as (3). The statistical arguments are founded on the observation that often in time series data there exist dependencies in the data over time. To capture these dependencies, dynamic specifications are necessary. Economic arguments focus on the lagged or dynamic adjustment to changes in economic variables. As instantaneous adjustment implies a static model, the arguments against instantaneous adjustment are also arguments against a static model. The hypothesis of habit formation discussed above is a dynamic model. However, other limitations on the adjustment process such as contractual obligations and imperfect information, which induce adjustment costs can also invalidate the hypothesis of instantaneous adjustment. These restrictions require more general dynamic specifications than the habit formation model. To model demand when these features are present, a general dynamic model is necessary. The advantage with (3) is that all linear dynamic structures are included as special cases.

Note that the habit formation model in (2) is a special case of (3) with r=1 and s=0. Each parameter in (3) gives the elasticity of one variable at a particular lag with respect to current consumption. The long-run elasticities are found by summing over all the lags. Hence, the long-run elasticities from (3) are $\eta_{ij} = \sum_l e_{ijl}(1-\sum_k c_{ik})^{-1}$ and $\eta_i = \sum_l e_{il}(1-\sum_k c_{ik})^{-1}$. An inconvenience with this model is that the long-run elasticities that are of greatest interest, must be computed after estimation. The model in (3) was therefore transformed into an Error Corection Model (ECM);

$$\text{(4)}\qquad \begin{aligned} \Delta \ln q_{it} &= \alpha_i + \sum_{k=1}^{r-1} C_{ik} \Delta \ln q_{it-k} + \sum_j \sum_{l=0}^{s-1} E_{ijl} \ln p_{jt-l} + \sum_{l=0}^{s-1} E_{il} \ln X_{t-l} \\ &\quad - \omega(\ln q_{t-r} - \sum_j \eta_{ij} \ln p_{jt-s} - \eta_i \ln X_{t-s}) \end{aligned}.$$

The advantage with this specification is that the long-run parameters (elasticities) are directly estimated. The parameter ω is also of interest as it may be interpreted as the adjustment speed towards equilibrium. An inconvenience with this specification is that it is nonlinear, requiring use of the more computationally difficult nonlinear estimation techniques.

Other single equation specifications similar to the double log but without or with only some logarithmic variables have also been used in the literature. These are, for instance, specifications where the data series are linear in their levels, see e.g. DeVoretz and Salvanes (1993). More recently, Box-Cox transformations have been estimated. The advantage with these models is that the functional form decides the right transformation of the variables, and includes the double log and the linear model as limit cases. An empirical example may be found in Bjørndal, Salvanes and Andreassen (1992).

Even if the major body of work on demand function estimation with single equation specifications has used quantity dependent models, there are examples where price is used as the dependent variable. This is especially true in studies of agricultural and fishery commodities (see e.g. Shonkwiler and Taylor, 1984). It must also be noted that the much studied problem of simultaneity in price and quantity has usually been formulated and studied with single equation demand (and supply) functions (Eales and Unnevehr, 1993).

This problem has generally been ignored in demand system specifications, as demand has been assumed to be completely price or quantity dependent.

There exist two major problems with single equation models. In general, they are not theoretically consistent. The most common of these specifications, the double log is theoretically consistent only when demand is independent of expenditure, i.e., the consumer's preferences are homothetic (Deaton and Muellbauer, 1980b, p. 17-18). This also violates Engel's law, which claims that the propensity to consume a particular group of goods varies with total expenditure. It should be noted that it is sometimes argued that in the analysis of a single commodity, where the functional form of the other goods in the system remains unspecified, the double log specification may give a satisfactory local approximation, in particular if there is not too much variation in total expenditure. For specifications linear in the variables and using the Box-Cox transformation, it is not possible to be theoretically consistent, possibly with the exception of an approximation point. This might be seen by noting that the demand equation cannot be homogenous of degree zero when using these specifications.

The single equation models specify uncompensated demand equations. The prices of the goods omitted from the specification may then cause problems because any change in either of them causes changes in demand for the commodity in question through changes in expenditure. This problem may be reduced if one specifies a compensated demand function (Stone, 1954a). In empirical work this problem may not be too serious, as the effect is small if the particular good represents a small portion of the budget.

In order to estimate demand functions that are consistent with utility maximisation, the concept of weak separability is used to separate a group of goods from the rest of the consumer's bundle. The demand functions for the goods inside the group are then specified in a system of demand functions where the restrictions associated with consumer theory can be tested or imposed (i.e. adding up, homogeneity, symmetry). These conditions, together with the trivial assumptions of positive prices and consumption, ensure that the demand system is consistent with consumer theory.[1] Most, but not all systems are derived from an explicitly formulated utility, indirect utility or cost function. However, this is not a necessary condition for theoretical consistency. Also, only demand systems are used in empirical work as it is not possible to measure or compare utility. For a discussion of the connection between the functional form of a utility, indirect utility or cost function and each of the demand systems where this can be explicitly formulated, see Pollak and Wales (1992). We will concentrate on demand systems in the following, where some of the most commonly used demand systems, the Rotterdam system and the almost ideal demand system, will be presented.

The Rotterdam System

In the Rotterdam system of Theil (1965) and Barten (1966; 1967; 1968), the demand equations are in budget share form and satisfy the adding up condition automatically. The symmetry and homogeneity restrictions implied by consumer theory may be expressed as linear functions of the estimated parameters. Consequently, one may either test if the data are in accordance with the consumer theory for this specification, or impose these restrictions on

[1] It should be noted that positive consumption is not absolutely necessary, and in some studies using cross section data at a micro level, zero consumption is allowed, see e.g. Heien and Wessells (1988; 1990), Wellman (1992) and Salvanes and DeVoretz (1993).

the estimated parameters to ensure theoretical consistency. Note that this, and most other empirical specifications, is an approximation to the underlying demand equations.[2] The results may in all specifications be dependent on the functional form. In particular, a rejection of the hypothesis of symmetry and homogeneity does not necessarily imply that the consumer theory is false. It might just as well be caused by model specification problems, of which choice of functional form is an important part.

Another improvement with the Rotterdam system compared to the linear expenditure system is that it allows for free estimation of price effects and this includes complements and inferior goods without losing theoretical consistency. Each equation in the Rotterdam system may be written as

(5) $$w_{it} d \ln q_{it} = b_i d \ln \bar{x}_t + \sum_j c_{ij} d \ln p_{jt} ,$$

where $w_{it} = \frac{p_{it} q_i}{x}$

$$d \ln \bar{x}_t = d \ln x_t - \sum_j w_{jt} d \ln p_{jt} = \sum_j w_{jt} d \ln q_{jt}$$

$$b_i = w_{it} e_i = p_{it} \frac{\partial q_{it}}{\partial x_t}$$

$$c_{ij} = w_{it} e_{ij}^* = \frac{p_{it} p_{jt} s_{ij}}{x_t}$$

Remember that e_i is the expenditure elasticity for good *i*. We also have that e_{ij}^* is the compensated cross-price elasticity, which is related to the uncompensated and expenditure

[2] It is of course possible to postulate that the consumers' preferences actually correspond to the demand equations from a particular functional form.

elasticities by Slutsky's equation on elasticity form, $e_{ij} = e_{ij}^* - e_i w_j$. The continuous difference operators *d*, in applied work, are replaced by their discrete approximation Δ.

The adding up restrictions imply that

(6) $$\sum_i b_i = 1, \quad \sum_i c_{ij} = 0.$$

These restrictions are automatically satisfied when the budget shares in the data set add to unity. However this restriction makes the covariance matrix singular. One must therefore delete one equation from the demand system before estimation. With correct estimation technique and an *iid*(0,*I*⊗*Σ*) error term, the system is invariant to which equation is deleted (Barten, 1969), and the adding up restrictions from (6) are used to retrieve the parameters in the deleted equation. This is also a feature the Rotterdam system has in common with all the other systems of demand equations formulated in their budget share equations. The symmetry and homogeneity restrictions may be expressed as functions of the parameters in the Rotterdam system. They may be written as:

(7)
Symmetry: $$c_{ij} = c_{ji}.$$
Homogeneity: $$\sum_j c_{ij} = 0.$$

As mentioned above, the restrictions may be used to test whether the data support a theoretically consistent specification of the Rotterdam system. They may also be imposed to ensure that the estimated system is theoretically consistent.

The Rotterdam system is common in the literature, and this work has been extended to an inverse demand approach (Barten and Bettendorf, 1989). The Rotterdam system differs from most other functional forms in that the underlying utility or cost functions have never been explicitly formulated, and that differential demand functions are used instead of functions formulated in the levels of the variables.

The Almost Ideal Demand System

The most common functional form in demand system specification since the early 1980s has been the almost ideal demand system (AIDS) of Deaton and Muellbauer (1980a). As with the Rotterdam and translog systems, the almost ideal demand system is formulated in terms of the budget shares, and each demand equation can be written as

$$(8) \qquad w_{it} = \alpha_i + \sum_j \gamma_{ij} \ln p_{jt} + \beta_i \ln\left(\frac{X_t}{P_t}\right),$$

where

$$\ln P_t = \alpha_0 + \sum_i \alpha_i \ln p_{it} + \frac{1}{2}\sum_i \sum_j \gamma_{ij} \ln p_{it} \ln p_{jt} \ .$$

The almost ideal demand system is linear except for the translog price index $\ln P_t$. This problem has traditionally been circumvented in most applied work as suggested by Deaton and Muellbauer, by using a Stone price index, i.e., $\ln P_t^* = \sum_i w_{it} \ln p_{it}$, which makes the system linear. Recently the use of the Stone price index has been shown to be inappropriate as it causes the estimated parameters to be inconsistent (Pashardes, 1993; Buse, 1994; Moschini, 1995). Moschini attributes this problem to the fact that the Stone price index does not satisfy what Diewert calls the commensurability property, and suggests that the problem may be solved by using a price index that satisfies this property.[3] Moschini suggests several other price indices that satisfy this property and may be used to keep a linear specification of

[3] The commensurability property means that a price index should be invariant to the unit of measurement for the prices.

the almost ideal demand system. He also shows that these indices perform as well as the translog index in a Monte Carlo experiment.

The restrictions to ensure theoretical consistency for the almost ideal demand system are:

Adding up: $\sum_i \alpha_i = 1, \quad \sum_i \gamma_{ij} = 0.$

(9) Symmetry: $\gamma_{ij} = \gamma_{ji}.$

Homogeneity: $\sum_j \gamma_{ij} = 0.$

The almost ideal demand system is parallel to the Rotterdam and translog systems in that the adding up restrictions are automatically imposed and one equation must be deleted before estimation to avoid a singular covariance matrix. The symmetry and homogeneity restrictions may be tested or imposed. There exist no clear criteria for choosing among the almost ideal demand system and the other two systems, and which functional form will perform best depends on the true structure in the underlying data. The almost ideal demand system has the advantage that it is linear and formulated in levels. It may accordingly be encountered as more intuitive and easier to use than the Rotterdam systems. In common with the Rotterdam system, the almost ideal demand system also has an inverse demand representation (Eales and Unnevehr, 1993).

3. MARKET INTEGRATION

While measuring the degree of substitution is the preferred way of determining to what extent commodities compete, the development or changes in prices overtime provides valuable information on the relationship among commodities. The importance of prices in defining markets was recognized early on by economists. In 1838 Cournot defined a market in the following way:

> *"It is evident that an article capable of transportation must flow from the market where its value is less to the market where its value is greater, until difference in value, from one market to the other, represents no more than the cost of transportation" (Cournot, 1971)*

Similar definitions have been provided by a number of prominent economists like Marshall (1947), Cassell (1918) and Stigler (1969). Stigler maintains the spirit of Cournot in defining a market as "the area within which the price of a commodity tends to uniformity, allowance being made for transportation costs". While Cournot and Stigler focus on geographical space the concept also applies to product space, where quality differences take the place of transportation costs (Stigler and Sherwin, 1985).

To motivate the Law of One Price (LOP) and price-founded definitions of a market, Figure 1 sketches the equilibrium for two markets. For expository purposes prices in both markets are initially normalized at P. Assume then that there is a supply shock in Market 1 that shifts the supply schedule to S1', giving p' and q1' as new price and quantity. This causes the price to decrease while the quantity increases. What happens in Market 2 depends on the degree of substitution between the two commodities.[4] If there is no substitution possibilities between the two markets/commodities there will be no change in price and quantity in Market 2. If the goods are perfect substitutes, the demand schedule in Market 2 is shifted down to D2' as consumers substitute commodity 1 for commodity 2, and the fall in price is just enough to equilibrate prices in both markets at $P^{'}$. (This is the Law of One Price.) If the goods are imperfect substitutes, the demand schedule in Market 2 is shifted down somewhat, say to D2'' but not enough to equate prices in the two markets.

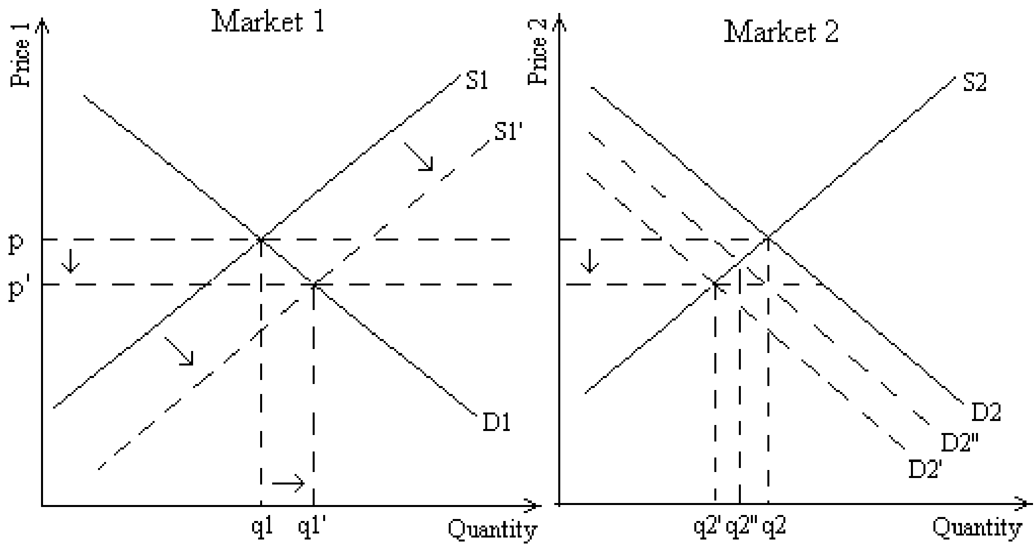

Figure 1. Potential Market Interaction Between Two Markets

As mentioned above, the strength of the influence of the shock in Market 1 on Market 2 is normally measured by the cross price elasticities which provide a measure of the shift in the demand schedule.[5] However, one can also look at the effect of the supply shock only from the price space. The price change in Market 1 can impact price in the other market in a number of ways. If there is no substitution effect, the demand schedule does not shift and there is no movement in price in Market 2. If there is a substitution effect the demand schedule in Market 2 shifts down, and the price in this market shifts in the same direction as the price in Market 1. At most the price in Market 2 can shift by the same percentage as the

[4] For completeness one should also mention that if the demand schedule in Market 2 shifts upwards, the two goods are complements.
[5] The same story can be told based on a demand shock, but where it is the producers that potentially adjust their supply.

price in Market 1, (i.e., the Law of One Price holds) and relative prices are constant. Hence, with respect to structural information about a market, analysis of relationships between prices can provide us with information of

1) whether the two markets (goods) do not compete,
2) whether they are imperfect substitutes,
3) whether they are perfect substitutes so that the relative price is constant.

This is then the basis for the hypotheses we want to test when investigating relationships between prices.[6]

Several studies have pointed out that the adjustment towards a new equilibrium can be delayed by adjustment costs (Ravallion, 1986; Slade, 1986; Goodwin, Grennes and Wohlgenant, 1990). This can be modeled when investigating relationships between prices by specifying a dynamic model. With a dynamic model one can also investigate whether the adjustment process is bi- or unidirectional. If causality goes only in one direction, this can be interpreted as price leadership for the price that does not adjust. This can be the case if there is one central market that affects the price in smaller regional markets.[7]

It is common in studies of market integration to perform the analysis on the logarithms of prices, and we will proceed using this transformation. Given time series on two prices, say, p_t^1 and p_t^2, the simplest specification to test for market integration is

(10) $$p_t^1 = a + bp_t^2 + e_t$$

[6] A negative relationship between the prices implies complements

[7] In product space, the quality of one commodity is the reference quality.

A null hypothesis that b = 0 is a test that no substitution possibilities exist. A null hypothesis that b=1 is a test for constant relative prices and the LOP.[8] The constant term a is the logarithm of a proportionality coefficient, and is zero if the prices are identical with exception of the arbitrary deviations caused by the error term. A nonzero constant term is in most cases interpreted as transportation costs or quality differences, which then are assumed to be constant.[9] Economic theory gives little guidance as to the choice of dependent variable, and the test is therefore often repeated by interchanging price variables in Equation (10).[10]

In the early 1980s, several authors argued that adjustment could be costly and therefore take time. To account for this, models were introduced with variable specifications that could distinguish between short- and long run effects. Slade (1986) used a simple model to account for dynamic adjustment to market integration.[11] This test is performed by first running the regression[12]

$$(11) \qquad p_t^1 = a + \sum_{j=1}^{m} b_j p_{t-j}^1 + \sum_{i=0}^{n} c_i p_{t-i}^2 + e_t$$

The lag structure on prices is chosen so that e_t is white noise. The data support a hypothesis that there is a relationship, or in statistical terms that p_t^2 causes p_t^1, if a joint test that all c_i

[8] See the analysis of Isard (1977) and Richardson (1978).
[9] Some authors argue that the assumption of constant transportation cost is to restrictive, and can at times cause tests to show less market integration then what there actually is. For instance, Goodwin, Grennes and Wohlgenant (1990) show closer market integration when transportation costs are explicitly modelled.
[10] This also gives rise to a simultaneity problem that often is acknowledged, but otherwise ignored. A good discussion can be found in Goodwin, Grennes and Wohlgenant (1990).
[11] Slade's (1986) analysis is an extension of Horowitz (1981), but Horowitz assumes more restrictive dynamics.
[12] In some cases, exogenous variables that represent common trends for the prices are also included.

parameters are zero is rejected.[13] Interchanging price variables in Equation (11), allows a test of the null hypothesis that p_t^1 causes p_t^2. In this dynamic specification, test results based on different dependent variables have an economic interpretation. If one price causes the other while the opposite causality does not hold, this is evidence of price leadership. If causality is not observed in any of the equations, this is evidence that the goods are not in the same market. A test for a long run LOP relationship corresponds to a test that the restriction $\sum b_j + \sum c_i = 1$ holds.[14] What is more, if the restrictions $c_o = 1, \ c_i = 0$ and $b_j = 0, \ \forall ij > 0$ cannot be rejected, this is evidence that the LOP holds in a static sense, and hence Equation (11) nests Equation (10).

In the 1980s economists became increasingly aware that most economic time series are nonstationary. This means that normal statistical inference is not valid for linear regressions on nonstationary data and casts doubt on the reliability of early results obtained using the approach described above. In general, for nonstationary data there will be no linear long-run relationship. However, it the data series in question have common stochastic trends, the linear combination of two nonstationary data series can be stationary and the data series are said to be cointegrated (Engle and Granger, 1987).

There are two common approaches to testing for cointegration; the Engle and Granger (Engle and Granger, 1987) test and the Johansen test (Johansen, 1988; 1991). The Engle and Granger test for cointegration is a straightforward regression procedure. However, there are

[13] This is in econometric terms a test for Granger noncausality (Granger, 1969).
[14] Ravallion (1986) discusses in more detail the interpretation of different restrictions on the dynamic process.

two problems with this test. First, it is subject to the same normalization problem in setting the dependent variable as with stationary data. Second, and more seriously, is that normal statistical inference and tests for the LOP are not valid, although cointegration tests for a (substitution) relationship between two commodities are possible. These problems are avoided when the Johansen approach is used.

3. DEMAND ELASTICITIES FOR FISH

In this section we will review demand studies related to fish and seafood published in international journals over the last decades. We start with the classic study of Bell (1968), which to our knowledge is the first study actually estimating a demand equation for a seafood product. In the 1970s and early 1980s very few studies of the demand for seafood products were published.[15] However, from the mid 1980s, there has been a substantial increase in the number of studies conducted, and therefore also of the markets and species covered.

We will focus on classical demand studies in the sense that a demand schedule must be estimated. There are also a number of studies obtaining market information from surveys, which at times will also give elasticity estimates. However, this type of study is mostly concerned with marketing issues, valuation issues, or seafood safety issues etc., and not relevant when one is interested in price-quantity relationships. An excellent review of this literature through the early 1990s can be found in Wessells and Anderson (1992). Another strand of literature which might be of interest is studies where fish/seafood is one aggregated good in a more general demand system that includes other foods and at times also other goods. Unfortunately, the focus is often on aspects other than demand elasticities in this kind of study, and we will therefore not pay too much attention to them. However, we do include studies where the seafood demand or the relationship between seafood and other goods are

[15] During this period there were some studies with regard to whitefish, see Schrank and Roy (1991).

an important part of the paper (e.g. Salvanes and DeVoretz (1997) or Johnson, Durham and Wessells, 1998).

As noted in the introduction, there are several caveats when comparing the results from a wide range of studies like we do here. One problem is that while some studies report elasticities, others report flexibilities. In many of the studies, the authors themselves use the flexibility estimates to obtain elasticities, and where this has not been done, we do it here by inverting the reported flexibilities. One should be aware that the inverse of a flexibility will be a consistent estimate of the elasticity only if the good in question has no substitutes. Otherwise, the inverted flexibility will provide a lower bound for the elasticity in question (Houck, 1965).

We will report the results from the studies considered here in a table (Table 1) that reports the product studied, own-price elasticity, the study, the type of data used, the region studied and whether a price dependent or quantity dependent model was used. These results will also be discussed and compared. The degree of substitution will receive less attention. However, one should be aware that in general, there are more substitutes for products with own-price elasticities of a higher magnitude.

When looking at the demand elasticities in Table 1 it is clear that there is substantial variation. However, two things become clear immediately. For most species, product groups and product forms, demand is elastic. In many cases the demand is also highly elastic. Demand for all categories are also found to be elastic in Guillotreau, Peredy and Bernard (1998); the study that uses the most aggregate data. However, the magnitudes also seem to vary systematically with model specification and measurement level for the data. This issue is addressed also by Schrank and Roy (1991).

There is a tendency that where the estimated model has price as the dependent variable, so the elasticity is calculated as the inverse of the flexibility, demand seems more elastic. This is as expected given the results of Houck (1965) in that inverted flexiblilities provide lower bounds for elasticities. The only study that provides both elasticities and flexibilities for the same data set is Eales, Durham and Wessells (1997). Here the magnitudes are to some extent comparable, although it should be noted that statistical tests indicate that the inverse system is better suited for this data set than the ordinary system. From Table 1 one can see that the magnitude of the inverted flexibilities is substantially higher than the elasticities, which is not too far away from –1. Although the differences in magnitudes cannot be generalized, these results show that the true elasticity may be substantially lower than the elasticities derived as inverse flexibilities. Moreover, it seems reasonable to assume that the difference is larger the more elastic the inverted flexibilities indicate that the demand is.

There also seems to be a tendency that demand is less elastic the closer one comes to the consumer in that retail demand seems to be least elastic while ex. vessel demand seems to be most elastic. However, this picture might also have other causes in that price dependent model specifications are more common the further the data is removed from the retail level. Also, in most specifications using data at the retail level and quite a few at the trade level, system specifications are used. This is uncommon with ex. vessel data as single equation specifications seem to be preferred. There is also a tendency that demand becomes less elastic the more recent the study. This might be caused by a move down along the demand schedule, but again specification issues might be important factors. There is a tendency that more recent studies use quantity dependent specifications and demand systems. Both these factors seem to push in the direction of making demand less elastic.

If one looks at the studies where retail level data is used in ordinary demand systems (Wessells and Wilen, 1993; 1994; DeVoretz and Salvanes, 1997; Eales, Durham and Wessells, 1997; Johnson, Durham and Wessells, 1998), we see that the demand elasticities tend to vary around –1, with an average quite close to –1. There are certainly deviations from –1, and as expected, there is a tendency that more valuable fish have more elastic demand. However, it should also be noted that the aggregation level for the data used in these studies is relatively high, and therefore this would tend to make demand less elastic. This is because the substitution possibilities are likely to be larger between similar disaggregated products than more dissimilar highly aggregated products.

Whitefish and related species, particularly flounders like plaice and sole, were the group of species that obtained most attention early on. This can be explained by the large importance of this group of species when measured by value particularly in the industrialized part of the world. The first that received attention were the fisheries of the Georgia and Grand Banks off the Atlantic coast of the US and Canada. The seminal study of Bell (1968) indicates that demand for all the species are elastic using price dependent models. However, with the exception of ocean perch which seems to be very odd, the magnitude of the elasticities is not too high. When one takes into account that a price dependent specification is used, the true elasticities are not likely to be very elastic and most likely not smaller than -2. Tsoa, Schrank and Roy (1982) contradict Bell's results in indicating that the demand elasticities for cod fillet in this area are highly inelastic (-0.46), and also find demand for redfish fillets to be inelastic. However, it should also be noted that the results of Tsoa, Schrank and Roy have been disputed, see Crutchfield (1986), Lin, Johnston and Rettig (1986) and Tsoa, Schrank and Roy (1986). This dispute is worthwhile to look into also as it highlights some of the difficulties that researchers face when one is interested in empirical estimates of demand elasticities for seafood. Other studies of whitefish species and flounders vary in their elasticity estimates, but in general the elasticities are either about –1 or more elastic.

The species that has received the most attention is salmon. This is not too surprising given that the fisheries for Pacific salmon have always been among the world's most valuable fisheries, and that the most successful species in intensive aquaculture is also salmon. The first studies were carried out in Canada and the US, with focus on wild Pacific salmon and the potential competition from salmon aquaculture (DeVoretz, 1982; Kabir and Ridler, 1984; Anderson and Wilen, 1986; Bird, 1986). With the exception of Bird (1986), all these studies indicate that the demand elasticity for salmon is highly elastic. However, it is worthwhile to note that DeVoretz found that the demand for canned salmon is substantially less elastic than the demand for fresh/frozen salmon.

Hermann and Lin (1988) estimate the demand for Norwegian farmed salmon, and with the exception of the studies that target the Japanese market, the demand for farmed salmon is the main focus of most of the studies from the 1990s. We will here not say anything about the results in Hermann, Mittelhammer and Lin (1992) and Asche (1997), as these two studies focus respectively on seasonality and dynamics. Given the large number of studies of different markets with different methods, it is as expected that the elasticity estimates differ substantially. However, Asche (1996) noted that a general trend seems to be that demand for salmon is getting less elastic. This is also as expected given that the total supply of salmon (both wild and farmed) has increased threefold from the early 1980s, and that this has led to shift down along the demand schedule. However, Bjørndal, Salvanes and Andreassen (1992) also indicate that generic marketing has led to an outward shift in demand. The reported elasticities are averages for data sets covering most of the 1980s and parts of the 1990s, and that total value of the salmon market has remained fairly constant over the last decade. It seems reasonable to assume that the demand elasticity for salmon is quite close to –1 at the present time. However, the elasticity does vary by product form and species, and demand for frozen Pacific salmon seems to be inelastic (Hermann, Mittelhammer and Lin, 1993; Asche, Bjørndal and Salvanes, 1998).

Catfish is the only other species where the aquaculture production has increased substantially over a period where the demand has been investigated to any extent. Since catfish was a low-value species to start with, its elasticity of demand was not too elastic. However, despite successful generic advertising, Kinnucan and Miao (1999) note that the elasticity has become less elastic with the increased supply, indicating a shift down along the demand schedule.

It is somewhat surprising that we do not observe the same tendency for whitefish. One of the main features of the whitefish market since the mid 1980s has been the increased internationalization and the introduction of Alaska pollock and Pacific hake to this market. However, it might be that most studies of demand for whitefish have been too early to pick up these changes or that the markets are so local that this does not matter too much. Myrland and Vassdal (1998) is an indication that the last point may be the most important, as they include Alaska pollock and hake in a whitefish system in the UK.

Tuna may be a species that is of large importance to the world's fishermen, yet the demand for tuna has received little attention. Wessells and Wilen (1993,1994) and Johnson, Durham and Wessells (1998) indicate that retail demand for tuna in Japan is close to –1, but inelastic. Wallström and Wessells (1995) indicate that demand for canned tuna in the US is highly inelastic.

Several other species like crawfish, scallops, shrimp, shellfish, tuna, halibut, lobster, cuttlefish, crabs, crustaceans has received some attention. However, as estimates exist from only one or a few studies it is not possible to generalize to any extent. The only obvious trend is that high-valued species tends to have more elastic demand.

In several studies, particular for whitefish and salmon, different product forms are also studied. It seems hard to generalize the results, with the exception that demand for canned products are more inelastic than demand for other product forms. It also seems like the fresh product form tends be the most elastic. One would also expect that demand for frozen blocks was more inelastic than for frozen fillets, but this does not seem to be the case.

DeVoretz and Salvanes (1997) and Johnston, Durham and Wessells (1998) also address the issue of competition between meat products and seafood products. Estimating systems which contain both types of product is important if the two types of products are not separable for the consumers. While the results are somewhat mixed, one can conclude that the substitutability between seafood and meat products are rather limited.

So far we have focused only on own-price effects, as they are the main topic of this study. However, while own-price effects are of interest on their own, in most cases one also needs information about substitution effects. These are measured by cross-price elasticities or flexibilities, depending on whether an ordinary or an inverse demand specification is used. Although it is difficult to generalise, it is clear that most seafood products have substitutes. Moreover, as expected similar species and product forms tend to be the closest substitutes. For instance, different species and product forms of salmon tend to be closer substitutes than any given salmon category and other seafood species/products.

4. EMPIRICAL MARKET INTEGRATION STUDIES

In this section, we will give a brief review of market integration results.. As there are a number of variations in what econometric approach is used, one can only sketch the results if one does not want to present each study in to large detail. The only common feature of all studies is that they test whether there is a statistically significant relationship between at least two different prices using an *F*-test for cointegration. In some studies there is no additional tests, while others test for the Law of One Price, leading prices, central markets, speed of adjustment etc.

The first study with respect to seafood that we are aware of is Squires, Herrick and Hastie (1989) who studied the relationship between sablefish prices in Japan and the US. They find that the Japanese and Alaska markets are integrated, while the US west coast is a separate market. This study is also notable as being the only one that treats prices as stationary.

Gordon, Salvanes and Atkins (1993) is the first in a string of studies that investigate the relationship between salmon and cod and other species, and are also the first to find that salmon is a separate market from other wild fish. Asche, Bjørndal and Young (2003), Asche, Gordon and Hannesson (2002; 2004) and Jaffry and Hartman (2003) are other studies providing similar results.

As in demand studies, salmon is the most studied species. Asche and Sebulonsen (1998), Asche, Bremnes and Wessells (1999) and Asche (2001) provide evidence that there is a global market for salmon including farmed as well as wild salmon. Asche et al (2005) show that salmon trout also belong to this market. However, Gordon and Clay show that at in the US, the different regional markets are segmented. Asche, Guttormsen and Tveterås (2002) and Asche and Guttormsen (2001) looks further into the micro structure showing that although there are seasonal variation in the prices for different weight classes of salmon, their prices are also highly related. In total, these studies indicate that there is a highly integrated market for salmon both globally, and for different product forms, and as such all forms of salmon are competing in the same market. Each product form or species need not be directly substitutable with any other, but there are so many species and product forms that are substitutable, that there is a link in the price formation process.

The whitefish market has also received substantial attention, including Gordon, Salvanes and Atkins (1993), Gordon and Hannesson (1996), Asche, Gordon and Hannesson (2002; 2004) Asche, Flaaten, Isaksen and Vassdal (2002), Jaffry and Hartman (2003) and Nielsen (2005).These studies indicate that all product forms of cod compete, although fresh is somewhat weaker related to the other product forms than frozen, frozen fillets, wet salted and dried salted cod. Cod is also a part of a larger whitefish market that includes haddock, saithe, hake and pollock. The keenest competition seems to be at the international trade/wholesale level, as the competition seems softer at the ex.-vessel level. Still, Asche, Flaaten, Isaksen and Vassdal (2002) find a high degree of price transmission between the different levels in the supply chain for cod. Jaffry (2004) shows that the price transmission is asymmetric for hake.

While salmon and whitefish are the most studied species, there are also studies investigating market integration either spatially or in product space for several other species and product forms. This includes Bose and McIlgrom (1996) study of tuna in Japan.

5. CONCLUDING REMARKS

In this paper, we have provided a review of demand and market integration studies for fish and seafood products. With a few notable exceptions, the demand for fish and seafood received little attention until the mid 1980s. However, from than on a number of studies for different product forms and markets have been carried out, using a number of different methodological approaches. This research has vastly increased our knowledge about fish and seafood markets. Salmon is the species that has been given most attention, as one might expect given the development of salmon aquaculture. Whitefish markets have also been the focus in a number of studies, and several other species have also received attention.

Given that estimating demand elasticities and testing for market integration is an empirical exercise, it is clear that each study must focus on a specific market for a given period of time. This is a problem since, strictly speaking, it gives information only about a given market for a given time period, and there is no reason why for example.that the demand for salmon in Japan should have any resemblance to the demand for cod in the UK. Moreover, a number of different model specifications have been used, making it even harder to compare results.

Demand in most markets seems to be price elastic. This is good news for the seafood industry in general, if one still regards it as a growing industry, as it implies that the total revenues are likely to increase if production continues to increase. However, it also implies that the market will give little help for conservation measures, as fishermen's income will fall if landings have to be reduced. It must also be noted that demand is not elastic in all market segments. For instance, the reported elasticities indicate that the demand for canned seafood in aggregate most likely is inelastic. Also for other species and product forms one can find examples of market segments where demand seems to be inelastic.

There seems to be a tendency that demand gets less elastic the closer to the consumer the data are measured, with retail demand the least elastic. Economic theory gives no reason to expect retail demand to be more or less elastic than demand lower in the value chain. This relationship will depend on the production process of the intermediaries (Gardner, 1975). One might of course speculate whether competition is keener in intermediary markets, as the fish can be processed into several product forms. However, the model specifications used might also be at least part of the reason for this result.

For species with a rapidly increasing production, like new aquaculture species such as salmon and catfish, the demand gets less elastic with increases in supply. This is very much as expected, as one in this situation is likely to observe a movement down the demand schedule. Hence, even though there is substantial evidence of successful generic marketing campaigns, it seems like lower prices facilitated by productivity improvements are more important in increasing the quantity sold of these species.

Finally, while most seafood products have several substitutes, the substitutes tend to be other seafood products. The degree of substitution between seafood and meat is substantially less. This indicates that fish and seafood are weakly separable from meat, so that the consumer first chooses between fish and meat, and then decides which species or product form to have. This notion receives support in Canada (Salvanes and DeVoretz, 1997), and seems to hold in one period, but not in another, as in Japan (Eales and Wessells, 1999).

In the end, it might be pertinent to ask whether there are any big holes in our knowledge about the demand for fish and seafood. Unfortunately, the answer is yes. The most obvious element missing is studies focusing on the demand for fish and seafood products from developing countries, both domestically and internationally. This is important as an increasing share of the world's seafood production originates in developing countries, and an increasing share of seafood exports comes from developing countries. As this is partly due to lack of data, this also leads us to the second important category that is missing.

Very little has been done on aggregate demand for species. As such, even though we know a bit about different markets at least for some species, we know substantially less about the aggregate markets. This is a major shortcoming, since the seafood markets are becoming more and more globalised. Knowledge about the global market structure is then instrumental in understanding the price determination process. There are most likely two reasons why aggregate demand structures have received little attention. First, it is very difficult to obtain good data. Second, there are substantial methodological issues both with respect to aggregation and because the simultaneity problem cannot be assumed away.

Lastly, although a number of studies of specific markets and species have been carried out, one would still like to see many more. This is partly because some important markets and species have received little attention. For instance, surprisingly little work has been carried out on demand for tuna. Also, for all species more studies will give us better foundations for generalisations. This might be particularly important since it is not very likely that too many aggregate studies will be carried out.

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Table 3.1. Demand elasticities

Product	Own-Price Elasticity	Study	Type of Data	Region	Dep. Var.
Sea scallops	-1.53	Bell (1968)	Ex. Vessel	USA	p
Yellowtail	-2.29	Bell (1968)	Ex. Vessel	USA	p
Large Haddock	-2.17	Bell (1968)	Ex. Vessel	USA	p
Small Haddock	-2.19	Bell (1968)	Ex. Vessel	USA	p
Cod	-3.15	Bell (1968)	Ex. Vessel	USA	p
Ocean Perch	-250.00	Bell (1968)	Ex. Vessel	USA	p
Whiting	-17.05	Bell (1968)	Ex. Vessel	USA	p
Canned, all	-7.14	DeVoretz (1982)	Wholesale	Canada	p
Canned Sockeye	-5.00	DeVoretz (1982)	Wholesale	Canada	p
Canned Pink	-13.70	DeVoretz (1982)	Wholesale	Canada	p
Canned Chum	-1.28	DeVoretz (1982)	Wholesale	Canada	p
Canned Coho	-1.64	DeVoretz (1982)	Wholesale	Canada	p
Fresh/froz	-8.33	DeVoretz (1982)	Wholesale	Canada	p
Fresh/froz Pink	10.00	DeVoretz (1982)	Wholesale	Canada	p
Fresh/froz Chum	2.04	DeVoretz (1982)	Wholesale	Canada	p
Fresh/froz Coho	50.00	DeVoretz (1982)	Wholesale	Canada	p
Cod fillets	-0.46	Tsoa, Schrank and Roy (1982)	Wholesale?	USA	q
Flatfish fillets	-1.04	Tsoa, Schrank and Roy (1982)	Wholesale?	USA	q
Redfish fillets	-0.70	Tsoa, Schrank and Roy (1982)	Wholesale?	USA	q
Fish blocks	-2.89	Tsoa, Schrank and Roy (1982)	Wholesale?	USA	q

Fresh salmon	-13.51	Kabir and Ridler (1984)	Apparent consumption	Canada	p
Fresh salmon	-10.75	Kabir and Ridler (1984)	Apparent consumption	Canada	p
Fresh salmon	-14.28	Kabir and Ridler (1984)	Apparent consumption	Canada	p
Fresh/froz. salmon	-10.00	Kabir and Ridler (1984)	Apparent consumption	Canada	p
Fresh/froz. salmon	-8.33	Kabir and Ridler (1984)	Apparent consumption	Canada	p
Fresh/froz. salmon	-10.75	Kabir and Ridler (1984)	Apparent consumption	Canada	p
Crawfish	-2.44	Bell, (1986)	Ex. vessel	USA	p
Pacific salmon	-3.62	Anderson and Wilen (1986)	Ex. vessel	USA	p
Salmon	-0.88	Bird (1986)	Ex.vessel	World	p
Pacific Halibut	-5.56	Lin, Richards and Terry (1988)	Ex. vessel	USA	p
Shellfish	-0.89	Cheng and Capps (1988)	Retail	USA	p
Finfish	-0.67	Cheng and Capps (1988)	Retail	USA	p
Norwegian Salmon	-1.83	Hermann and Lin (1988)	Trade	EU	q
Norwegian Salmon	-1.97	Hermann and Lin (1988)	Trade	USA	q
Haddock	-8.33	Barten and Bettendorf (1989)	Ex Vessel	Belgium	p
Cod	-8.33	Barten and Bettendorf (1989)	Ex Vessel	Belgium	p
Whiting	-7.69	Barten and Bettendorf (1989)	Ex Vessel	Belgium	p
Redfish	-11.11	Barten and Bettendorf (1989)	Ex Vessel	Belgium	p
Plaice	-5.26	Barten and Bettendorf (1989)	Ex Vessel	Belgium	p
Sole	-9.09	Barten and Bettendorf (1989)	Ex Vessel	Belgium	p
Ray	-2.70	Barten and Bettendorf (1989)	Ex Vessel	Belgium	p
Turbot	-2.86	Barten and Bettendorf (1989)	Ex Vessel	Belgium	p
Whitefish	-0.95	Burton (1992)	Retail	UK	q
Smoked Whitefish	-1.50	Burton (1992)	Retail	UK	q

Fat fish (Pelagic)	-1.60	Burton (1992)	Retail	UK	q
Other	-0.40	Burton (1992)	Retail	UK	q
Fresh salmon	-1.30	Bjørndal, Salvanes and Andreassen (1992)	Wholesale	France	q
Atlantic salmon	-1.92	DeVoretz and Salvanes (1993)	Trade	EU	q
Atlantic salmon	-2.00	DeVoretz and Salvanes (1993)	Trade	USA	q
Atlantic salmon	-2.38	DeVoretz and Salvanes (1993)	Trade	World	q
Norwegian salmon	-1.94	Hermann, Mittelhammer and Lin (1993)	Trade	EU	q
Norwegian salmon	-1.35	Hermann, Mittelhammer and Lin (1993)	Trade	USA	q
Norwegian salmon	-2.28	Hermann, Mittelhammer and Lin (1993)	Trade	Japan	q
High-value salmon	-1.88	Hermann, Mittelhammer and Lin (1993)	Trade	EU	q
High-value salmon	-3.02	Hermann, Mittelhammer and Lin (1993)	Trade	Japan	q
Low-value salmon	-1.16	Hermann, Mittelhammer and Lin (1993)	Trade	EU	q
Low-value salmon	-1.92	Hermann, Mittelhammer and Lin (1993)	Trade	Japan	q
Fresh salmon	-1.28	Wessells and Wilen (1994)	Retail	Japan	q
Salted salmon	-1.00	Wessells and Wilen (1994)	Retail	Japan	q
Tuna	-0.93	Wessells and Wilen (1994)	Retail	Japan	q
Cuttlefish	-0.98	Wessells and Wilen (1994)	Retail	Japan	q
Cod roe	-0.98	Wessells and Wilen (1994)	Retail	Japan	q
Horse mackerel	-1.28	Wessells and Wilen (1994)	Retail	Japan	q
Flounder	-1.24	Wessells and Wilen (1994)	Retail	Japan	q
Yellowtail	-1.25	Wessells and Wilen (1994)	Retail	Japan	q
Sea bream	-0.49	Wessells and Wilen (1994)	Retail	Japan	q
Shrimp, lobster	-1.37	Wessells and Wilen (1994)	Retail	Japan	q
Shellfish	-0.55	Wessells and Wilen (1994)	Retail	Japan	q

Other	-0.83	Wessells and Wilen (1994)	Retail	Japan	q
Norwegian Salmon	-1.27	Bjørndal, Gordon and Salvanes (1994)	Trade	Italy	q
Norwegian Salmon	-1.78	Bjørndal, Gordon and Salvanes (1994)	Trade	Spain	q
Domestic shrimp	-0.45	Sun (1995)	Trade/Ex. vessel	USA	q
Farm-raised shrimp	-0.34	Sun (1995)	Trade/Ex. vessel	USA	q
Wild-caugt shrimp	-0.57	Sun (1995)	Trade/Ex. vessel	USA	q
Seafood	-0.14	Huang (1995)	Retail	USA	q
Canned Tuna	-0.47	Wallström and Wessells (1995)	Retail	USA	q
Alaska Snow and Tanner Crab	-1.43	Greenberg, Herrmann and McCracken (1995)	Wholesale	USA	p
Alaska Snow and Tanner Crab	-1.72	Greenberg, Herrmann and McCracken (1995)	Wholesale	Japan	p
Catfish	-1.01	Zidack, Kinnican and Hatch (1995)	Wholesale	USA	q
Fresh salmon	-1.73	Asche (1996)	Trade	EU	q
Frozen salmon	-0.28	Asche (1996)	Trade	EU	q
Smoked salmon	-0.60	Asche (1996)	Trade	EU	q
Frozen cod fillets	-1.89	Mazany, Roy and Schrank (1996)	Trade/Ex. vessel	Canada/USA	q
Frozen cod blocks	-3.16	Mazany, Roy and Schrank (1996)	Trade/Ex. vessel	Canada/USA	q
High-value fresh fish	-1.67	Eales, Durham and Wessells (1997)	Retail	Japan	p
Medium-value fresh fish	-1.82	Eales, Durham and Wessells (1997)	Retail	Japan	p
Low-value fresh fish	-3.13	Eales, Durham and Wessells (1997)	Retail	Japan	p
Crustaceans	-4.17	Eales, Durham and Wessells (1997)	Retail	Japan	p
Cuttlefish, squid and octopus	-2.38	Eales, Durham and Wessells (1997)	Retail	Japan	p

Shellfish	-2.17	Eales, Durham and Wessells (1997)	Retail	Japan	p
High-value fresh fish	-0.99	Eales, Durham and Wessells (1997)	Retail	Japan	q
Medium-value fresh fish	-1.18	Eales, Durham and Wessells (1997)	Retail	Japan	q
Low-value fresh fish	-0.67	Eales, Durham and Wessells (1997)	Retail	Japan	q
Crustaceans	-0.85	Eales, Durham and Wessells (1997)	Retail	Japan	q
Cuttlefish, squid and octopus	-1.09	Eales, Durham and Wessells (1997)	Retail	Japan	q
Shellfish	-0.92	Eales, Durham and Wessells (1997)	Retail	Japan	q
Red meat	-0.69	Salvanes and DeVoretz (1997)	Retail	Canada	q
White meat	-0.93	Salvanes and DeVoretz (1997)	Retail	Canada	q
Processed meat	-0.86	Salvanes and DeVoretz (1997)	Retail	Canada	q
Fresh fish	-0.91	Salvanes and DeVoretz (1997)	Retail	Canada	q
Cured fish	-0.96	Salvanes and DeVoretz (1997)	Retail	Canada	q
Canned fish	-0.98	Salvanes and DeVoretz (1997)	Retail	Canada	q
Other fish	-0.94	Salvanes and DeVoretz (1997)	Retail	Canada	q
Residual food	-0.88	Salvanes and DeVoretz (1997)	Retail	Canada	q
Fresh Salmon	-3.73	Asche, Salvanes and Steen (1997)	Trade	EU	q
Frozen Salmon	-2.57	Asche, Salvanes and Steen (1997)	Trade	EU	q
Crustaceans	-1.56	Asche, Salvanes and Steen (1997)	Trade	EU	q
Catfish	-0.87	Kinnucan and Thomas (1997)	Wholesale	USA	q
Salted salmon	-0.89	Johnson, Durham and Wessells (1998)	Retail	Japan	q
Salmon	-1.43	Johnson, Durham and Wessells (1998)	Retail	Japan	q
Tuna	-0.85	Johnson, Durham and Wessells (1998)	Retail	Japan	q
Flatfish	-0.54	Johnson, Durham and Wessells (1998)	Retail	Japan	q

Lobster/shrimp	-1.11	Johnson, Durham and Wessells (1998)	Retail	Japan	q
Shellfish	-0.59	Johnson, Durham and Wessells (1998)	Retail	Japan	q
Cuttlefish	-1.08	Johnson, Durham and Wessells (1998)	Retail	Japan	q
Other	-0.80	Johnson, Durham and Wessells (1998)	Retail	Japan	q
Fresh salmon	-1.33	Asche, Bjørndal and Salvanes (1998)	Trade	EU	q
Frozen Atl. Salmon	-1.86	Asche, Bjørndal and Salvanes (1998)	Trade	EU	q
Frozen Pac. salmon	-0.51	Asche, Bjørndal and Salvanes (1998)	Trade	EU	q
Hake	-1.92	Millan and Aldaz (1998)	Ex. Vessel	Spain	p
Octopus	-1.75	Millan and Aldaz (1998)	Ex. Vessel	Spain	p
Squid	-2.70	Millan and Aldaz (1998)	Ex. Vessel	Spain	p
Frozen hake	-5.00	Millan and Aldaz (1998)	Ex. Vessel	Spain	p
Other fresh	-1.45	Millan and Aldaz (1998)	Ex. Vessel	Spain	p
Other frozen	-2.27	Millan and Aldaz (1998)	Ex. Vessel	Spain	p
Frozen octopus	-2.70	Millan and Aldaz (1998)	Ex. Vessel	Spain	p
Frozen Squid	-2.33	Millan and Aldaz (1998)	Ex. Vessel	Spain	p
Seafood	-1.35	Guillotreau, Peridy and Bernard (1998)	Trade	EU	q
Fish	-1.05	Guillotreau, Peridy and Bernard (1998)	Trade	EU	q
Shellfish	-2.04	Guillotreau, Peridy and Bernard (1998)	Trade	EU	q
Norwegian peeled shrimp	-1.89	Myrland og Vassdal (1998)	Trade	UK	q
Icelandic peeled shrimp	-1.08	Myrland og Vassdal (1998)	Trade	UK	q
Danish shell-on shrimp	0.02	Myrland og Vassdal (1998)	Trade	UK	q
Danish peeled shrimp	-0.67	Myrland og Vassdal (1998)	Trade	UK	q
Thai peeled shrimp	-0.26	Myrland og Vassdal (1998)	Trade	UK	q
Frozen fillets of cod	-1.22	Myrland og Vassdal (1998)	Trade	UK	q

Frozen cod	-1.06	Myrland og Vassdal (1998)	Trade	UK	q
Fresh fillets of haddock	-0.89	Myrland og Vassdal (1998)	Trade	UK	q
Frozen fillets of Alaska pol.	-0.69	Myrland og Vassdal (1998)	Trade	UK	q
Frozen fillets of hake	-0.82	Myrland og Vassdal (1998)	Trade	UK	q
High Quality Fish	-0.82	Eales and Wessells (1999)	Retail	Japan	q
Medium Quality Fish	-0.75	Eales and Wessells (1999)	Retail	Japan	q
Low Quality Fish	-0.98	Eales and Wessells (1999)	Retail	Japan	q
Sole	-4.00	Jaffry, Pascoe and Robinson (1999)	Ex. Vessel	UK	p
Bass	-2.63	Jaffry, Pascoe and Robinson (1999)	Ex. Vessel	UK	p
Turbot	-3.45	Jaffry, Pascoe and Robinson (1999)	Ex. Vessel	UK	p
Lobster	-5.26	Jaffry, Pascoe and Robinson (1999)	Ex. Vessel	UK	p
Catfish	-0.71	Kinnucan and Miao (1999)	Wholesale	USA	q