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Vertical Relationships in the Value Chain: An Analysis Based on Price Information for Cod and Salmon in Europe

by

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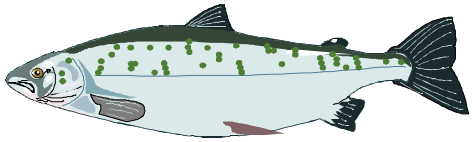

Margins along the European seafood value chain
Impact of the salmon industry on market structures

SNF · University of Portsmouth · SAC · LEN CORRAIL · OIKOS · FOFRI

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VERTICAL RELATIONSHIPS IN THE VALUE CHAIN:

AN ANALYSIS BASED ON PRICE INFORMATION FOR COD AND SALMON IN EUROPE

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1. Introduction

During the last decades, distribution and processing has become more concentrated in many industries. This is due to innovations in processing, transports, distribution and logistics that increase the efficient scale of operation. The potential scale economies and concentration increase the possibility to exploit market power for those firms with key location in the value chain (Tirole, 1988). On the other hand, the increased scale of production may well lead to concentration to exploit the economies of scale without enabling firms to exploit market power (Paul, 2001).[1] As demonstrated in Guillotreau and Le Grel (2001), this is a highly relevant issue in relation to seafood, as many value chains experience substantial changes that lead to higher concentration due to e.g. increased production of farmed fish and increased concentration of retailers as the share of food that is sold through supermarkets increase.

A problem when investigating market behavior in relation to market power is that the data requirements are extensive and the modelling process nontrivial (Bresnahan, 1989; Paul, 2001). In this report we will investigate what information can be obtained about the structure of the value chain using only price data. The advantage with prices is that they are more readily available than many other forms of data, and analyses can be conducted in chains where only limited information is available. However, this comes at the cost that less precise information may be obtained using this approach compared with other approaches. The key insight is similar to what is used in the pricing to market literature in international trade (Krugman, 1987; Knetter, 1993) in that cost increases for a seller will be fully passed on to a consumer only if the market is competitive. However, the criterion is not as straight forward as when trade across borders is investigated, as the potential substitution of different inputs needs to be taken into account (in an international trade situation, exchange rates affects all costs).

This approach will be used to study the value chains for three key species of fish in Europe. These species are cod, hake and salmon. For cod we study the value chain between Norway and Portugal and also the chain within the United Kingdom. For hake we study the chain for domestic producers in France, as well as for British exports to France, and for salmon we study several chains across Norway, Finland, France and the United Kingdom, with trade emanating from the main producers, Norway and Scotland. Statistical analysis is carried out for each of these case studies to determine to what extent prices are related for the same species at different stages of the value chain. The methodology used in the study is based on cointegration techniques. This methodology is well established and has been widely applied to studies of fish markets (Bose and Mcilgrom, 1996; Gordon and Hannesson, 1996; Asche, Salvanes and Steen, 1997; Asche, Bremnes and Wessells, 1999; Jaffry, Pascoe and Robinson, 1999; Asche, Hartmann and Jaffry, 2000, Jaffry *et al*, 2000, Asche, 2001, Asche and Guttormsen, 2001).

The first case study to be looked at is for dried-salted cod trade between Norway and Portugal. Norway's exports of cod dates back at least a millennium, and cod has

[1] In such a case, the produced quantity in phase I in Viener's (1931) categorisation of the firms production possibilities has increased, and hence, fewer firms are needed to produce the required quantity. However, as these local economies of scale always will be exploited, this does not enable any firm to exercise market power.

always been an important industry along the Norwegian coast.[2] Portugal's consumption traditions are almost as old. However, the trade between Norway and Portugal has increased substantially due to the decline of the Portuguese cod fishing fleet following the introduction of a 200 mile Exclusive Economic Zones (EEZ).[3] This has meant that Portugal has become almost completely reliant on imported cod to supply its large domestic market for dried salted cod (dried salted cod represents around 40 percent of domestic fish consumption in Portugal). It must here be noted that virtually all cod consumed in Portugal is dried salted cod. Hence, imports of other product forms are only inputs to the Portuguese salting and drying industry. The majority of imported cod comes from Norway as dried salted or salted cod. However, while dried salted cod is available only from Norway, there are several sources for salted cod. In the 1990s Portuguese imports of frozen cod, for which there is a world market, increased substantially to partly replace salted cod as an input to the Portuguese salting and drying industry.

The second case study to be investigated is for cod in the United Kingdom. Cod is the traditional favorite food fish in the United Kingdom, and as a result demand for this species in consumption is high. As domestic landings of cod have dwindled, the United Kingdom has become increasingly reliant on imports. These imports are mainly in frozen form from Iceland, Norway, the Faroe Islands and Russia. Increased imports of cod have changed dramatically the structure of the value chain for whitefish in the UK. In order to cope with large import volumes processing firms have become larger and fewer. In addition, these firms have forged direct links with importers, rather than going through wholesalers. At the same time as import volumes have been growing the retail sector for whitefish has been concentrating such that it is now made up of a few large supermarket chains. Processing firms have also forged direct links with these supermarket chains, again bypassing the role of wholesalers in the value chain. The net result of these changes has been that the value chain for whitefish in the UK has become increasingly vertically integrated.

The third case study is for salmon traded between the United Kingdom, Norway, France and Finland. The European salmon market is one of the biggest in the world. However, unlike the long history of cod harvesting, the growth of the salmon market has been fairly recent. Growth in this market has developed as a result of recent technological progress in the breeding of salmon since the late 1970s and early 1980s. The two major producers of salmon are Norway (360,000 tonnes in 1998) and the United Kingdom (115,000 tonnes in 1998). Both these countries export a large proportion of their production to France, which is the largest single market in Europe for salmon. Norway also exports salmon to the United Kingdom (about 15,000 tonnes in 1998), that competes with domestically produced salmon in the value chain in the UK. Finland is a relatively small market for salmon. Its imports come almost exclusively from Norway, and in 1998 Finland imported around 5,000 tonnes of salmon (this is about 1.4%, of the total Norwegian production). However, this trade is of interest as there is a large market for farmed salmon trout in Finland (15,900 tonnes produced in 1998), which is thought to compete with imports of salmon from Norway in domestic consumption. This competition is only recent, as up until 1993 restrictions were placed on imports of salmon into Finland. Salmon is traded, and

[2] See Kurlansky (1997) for a highly entertaining story of the cod fisheries and trade.
[3] This trade was substantially hindered in the mid 20th century by import restrictions in Portugal.

consumed, in both fresh and smoked form in all four countries (Guillotreau and Le Grel 2001). Smoked salmon is particularly important in France, where more then 30% of total salmon imports are consumed as smoked. A substantial share of this salmon is smoked in France, and the output from these firms then competes with imported smoked salmon mainly from the UK and Denmark.

This report will be organised as follows. In chapter 2 we discuss the theoretical framework. In chapter 3 we give an overview of the methodology to be applied. In chapter 4 we report the data sources and investigate the data series time series properties as a preliminary for the empirical analyses. In chapters 5, 6and 7 we report results from statistical analysis of each of the cases respectively: cod in Norway and Portugal, cod in the United Kingdom and salmon. In chapter 8 a discussion of the results and concluding remarks is offered.

2. Theory

In this chapter we will look at different theoretical issues with respect to margins along the value chain, and particularly at what information one can derive using only price information. We will start with the competitive case, as this is the workhorse in most of microeconomic analysis, and is also the most common model when looking at the value chain. We will continue with a discussion of some of the elements related to market power at certain stages of the chain. This is highly relevant as many value chains, including the chain for seafood, during the last decades has become more concentrated. Hence the scope for market exercising power has increased (Guillotreau and Le Grel, 2001). Pricing behavior also in the value chain with market power has also been an important part of the new research agenda in Industrial Organization (Tirole, 1988). However, it should be noted that concentration and/or economies of scale is a necessary, but not sufficient, condition to enable firms to exercise market power. This is an issue that has recently received more attention, and is forcefully stated in e.g. Paul (2001).

2.1. The value chain

The observation that the primary producer is often not the same as the seller of a product to the consumer was made early in the 20th century, and many leading economists including Hicks (1957) and Friedemann (1962) have made contributions with respect to how intermediaries operate along the value chain. Since analysis of margins is often of policy interest, much of the literature is empirical in nature, and one often goes from empirical tractable special cases to more complex theoretical derivations. This is true for the competitive case (Wohlgenant, 1989), and even more so when some agents are assumed to have market power (Tirole, 1988).

Tomek and Robinson (1981, p.121) give two alternative definitions of the marketing margin:

> "as (1) a difference between the price paid by consumers and that obtained by producers, or as (2) the price of a collection of marketing services which is the outcome of the demand and supply for such services."

Both definitions are very interesting. The first one basically states what we in everyday language think of as the margin, while the second one hints at the economic forces that causes the existence of the margin and why it is changing. It should also be noted that by the existence of the term margin, one implies that these intermediate factors are often of secondary interest and importance.

The fact that the value chain contains intermediaries has two further implications. First, the commodity purchased by a consumer is in general a composite commodity consisting of the primary product and the marketing services. Second, the intermediaries have the potential to distort signals through the value chain, as these agents have their own separate profit maximization problem. One can show that how much intermediaries can distort signals through the chain depends on how important the marketing services are in the final product and to what extent they can exercise

market power. This will be discussed later. However, it is worthwhile to note that only the retail outlets face the "demand" or consumer demand for the product. Other suppliers at lower levels in the chain face demand derived from the retailer's profit maximization problem and possibly also from other intermediaries. All demand schedules along the value chain, excluding but retail demand, are therefore known as *derived* demand.

2.2. Competitive suppliers

In this section we will look at the value chain with price taking agents at all levels, where the basic model is based on Heien's (1980) exposition. Consumer demand is assumed to be a standard demand equation derived from a utility maximizing consumer with standard regularity conditions applying (see e.g. Deaton and Muellbauer (1980) for regulatory conditions for consumer demand).[4] Retail demand can then be expressed as a function of retail price r and a vector m of exogenous factors like income and substitute prices. This can then be written as

(1) $$R^d = h_1(r, m)$$

We will model only one intermediate firm in this exposition, as all intermediary firms will have a similar structure, although the marketing input may change. The intermediary firm's optimization problem can then be described by a profit function

(2) $$\Pi(r, w, z) = ry - C(y, w, z)$$

Here, r is the price of the good that the intermediary sells, w is the price of the primary product the firm buys and z is the price of the marketing input (this can of course be taken to be a vector of prices, but we will for simplicity treat it as a scalar as is common in this literature) and C is a cost function with output level y. Standard regulatory conditions are assumed to hold for the profit and cost function (MacFadden, 1978; Diewert, 1982). If the firm maximizes profits, we will in optimum have that

(2') $$p = C_y(y, w, z)$$

where the subscript denotes the derivative with respect to this variable. This equation then gives the well known condition price is equal to marginal cost.

Hotelling's lemma indicates that the derivatives of the profit function with respect to prices will give us respectively the supply and the two input demand equations of the firm. The supply equation can be written as

(3) $$R^s = h_2(r, w, z)\ ,$$

[4] By a standard demand equation we mean that the good in question is not a Giffen good, so that also the uncompensated demand equation has to be downward sloping.

the demand for the primary product input as

(4) $$W^d = h_3(r, w, z),$$

and the demand for the marketing input as

(5) $$Z^d = h_4(r, w, z)$$

If the retailer buys directly from the primary producer, equation (4) will be the demand faced by the primary producer. Alternatively, if there is more intermediaries like a wholesaler, the wholesaler will face a demand schedule like equation (4) for the primary product, but also have a demand equation like (4) for the primary product to the supplier one level further down in the chain. At the bottom of the chain is a primary product producer that has a similar optimisation problem for producing the good, from which one can derive the primary supply for the good

(6) $$W^s = h_5(w, x)$$

Here, x is the prices of the inputs used by the primary producer.

In a static representation quantity demanded and supplied will be equal at each level. However, in particular if mark-up rules are used and/or inventories are held, this is not likely (Heien, 1980). Following Samuelson (1961, p. 260-269), one can use an excess demand approach to specify price adjustment equations at the different levels as

(7) $$r = h_6(R^d - R^s)$$

(8) $$w = h_7(W^d - W^s)$$

This will imply a dynamic relationship between the prices at different levels along the value chain. The cause of this dynamic relationship is adjustment cost. Originally these were attributed to cost of storage, but more recently they have been attributed to costly information and menu costs. If adjustment costs are present, the short-run response to price changes will be less than the long-run response.

To see how the interaction between the demand for the primary product and the marketing output distorts the signals between the retailer and primary supplier we will use a relationship shown to hold under a constant returns to scale technology by Hicks (1956) and Gardner (1975). In the case where the intermediaries' production technology uses two inputs, a primary product a and marketing good b, and is characterised by constant returns to scale, the relationship between the derived demand own-price elasticity for input a, E_a, and the consumer demand own-price elasticity η, may be expressed as;

(9) $$E_a = \frac{\eta\sigma + e_b(S_a\eta - S_b\sigma)}{e_b + S_a\sigma - S_b\eta}$$

where σ is the elasticity of substitution between the two inputs, e_b is the supply elasticity for input *b*, and S_a and S_b are the cost shares for inputs *a* and *b* respectively. The derived demand elasticity will be less elastic than the consumer demand elasticity if $\sigma < |\eta|$, it will be more elastic if $\sigma > |\eta|$ and it will be equal to the consumer demand elasticity if $\sigma = |\eta|$. In general, these relationships will not be stable since elasticities are functions of prices and quantities. Hence, even if the condition $\sigma = |\eta|$ holds at one point, one will not expect it to hold for other price and quantity realisations. Equation (9) implies that the intermediary will respond to price changes at farm or retail level partly by changing the demand for the primary product, and partly by adjusting marketing effort. The changes in marketing effort will distort the signal from the retail level to the farm level, and vice versa, and is therefore the reason why the derived demand elasticity does not coincide with the retail demand elasticity.

Since it is the interaction between the primary product and the marketing factor that causes the difference in the two elasticities, one response in the literature has been to assume that the relationship between the retail and derived demand elasticities are linear (George and King, 1971). The relationship is then given as

$$E_a = \eta E_T . \tag{10}$$

where E_T is the elasticity of price transmission. The elasticity of price transmission is the elasticity of the consumer price with respect to the input factor price.[5] This assumption makes the relationship between the retail demand and derived demand elasticities proportional, but in general they will not be equal. This will only happen when the price transmission is perfect, i.e. when the elasticity of price transmission is equal to 1. Moreover, Gardner (1975) shows that this expression is correct only when the intermediaries' production technology is characterised by fixed factor proportions (i.e., the elasticity of substitution is zero). Equation (9) will then reduce to;

$$E_a = \frac{e_b S_a \eta}{e_b - S_b \eta} . \tag{11}$$

Note that in this case the derived demand elasticity in general will be less elastic than the consumer demand elasticity as $0 = \sigma < |\eta|$. This implies that the elasticity of price transmission is less than one, so that shocks in primary prices are only partly reflected in consumer prices.[6]

2.3. Price pass-through under competition

In the competitive case it is well known that long-run profits, i.e. equation (2) will be zero. From this it follows that all changes in costs will be fully passed on the next level in the value chain and ultimately to the consumer. This can also be seen from (2'), as any change in marginal cost must be reflected in the price if the firm is not to

[5] Although the elasticity of price transmission does not have to be constant, it is in general assumed to be constant and is often estimated as a single parameter (see e.g. Kinnucan and Forker, 1987).

[6] This is consistent with the common observation that price volatility tends to be less at the retail level relative to the producer level given that the supply shock at the primary level is larger than the demand shocks at the retail level.

operate with a loss. If a firm in a competitive industry cannot completely pass on its cost changes to the next stage in the value chain, it will therefore go out of business. However, as is obvious from the discussion in the preceding section, the intermediaries will reduce the cost increase as much as possible by substituting the primary product input for the marketing input and vice versa. As long as the intermediaries have substitution possibilities, it then follows that the price pass through of changes in the price of the primary product (or marketing good) will be less then perfect.

An interesting question is then whether the derived demand elasticity will equal the consumer demand elasticity under any other conditions than $\sigma = |\eta|$. As noted by Asche *et al* (2002), the answer is yes, if the intermediaries' production technology may be represented with only one variable input. If S_a is equal to one and S_b is equal to zero, it is easily seen that equation (9) reduces to

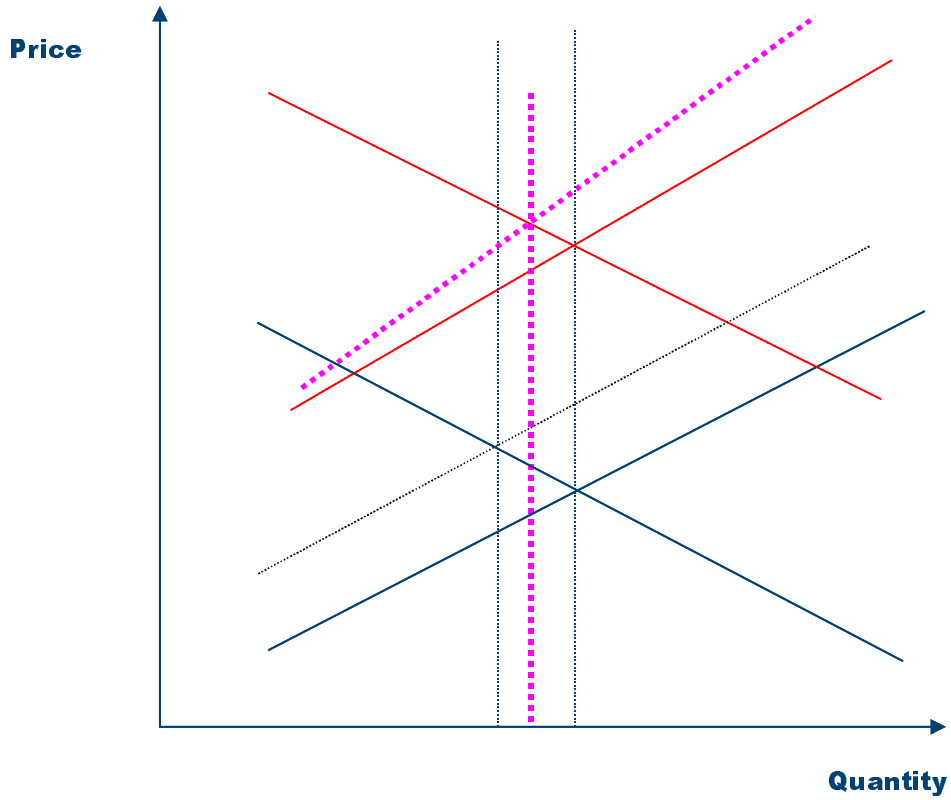
(12) $E_a = \eta$.

Since equations (10) and (11) are special cases of equation (9), this is also true for these equations, implying that the elasticity of price transmission in general will be 1, giving perfect price pass through only under two conditions; when $\sigma = |\eta|$, or when the production technology can be regarded as having only one input. Of these two conditions only the last one will in general hold for all price levels.

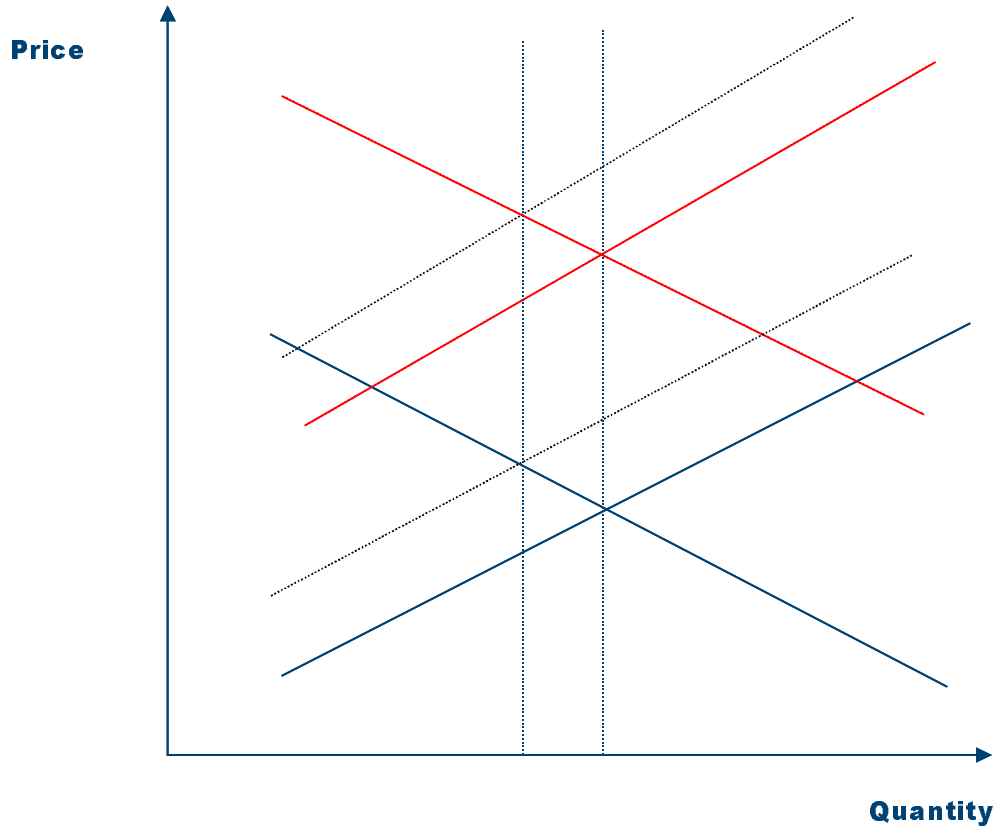
The difference between perfect pass-through and nonperfect pass-through can be illustrated as in Figure 2.1. Here, there are two market crosses normalized so that the quantity is the same. The lower market cross is supply and demand at the primary level, while the upper is supply and demand at the retail level. Assume then that supply shifts at the primary level. In the first panel where there is perfect passthrough the intermediaries supply will then shift exactly so much that the quantity remains the same at the two levels (and the price change is proportional). In the second panel the quantities at the two levels now differ, as the supply shift is partly accommodated in higher use of other factors by the intermediaries.

The condition that an intermediary has a production technology with only one variable input may seem restrictive, since it implies that all marketing inputs are treated as fixed costs. For many retailers, wholesalers and light processing activities, a production technology with only one variable input factor might still be a reasonable description of their short-run production technology. A supermarket, for instance, is operating in a given building with a fairly fixed amount of shelf space, and also has a fairly fixed labour force. A notable change in any of these variables will lead to a significant change in the supermarket's sales strategy. Moreover, while the cost of the goods sold are clearly the largest cost component, no single good is likely to be so important that it might change the sales strategy. A pricing strategy based on some

Figure 2.1: The difference between perfect pass-through and nonperfect pass-through



Panel a

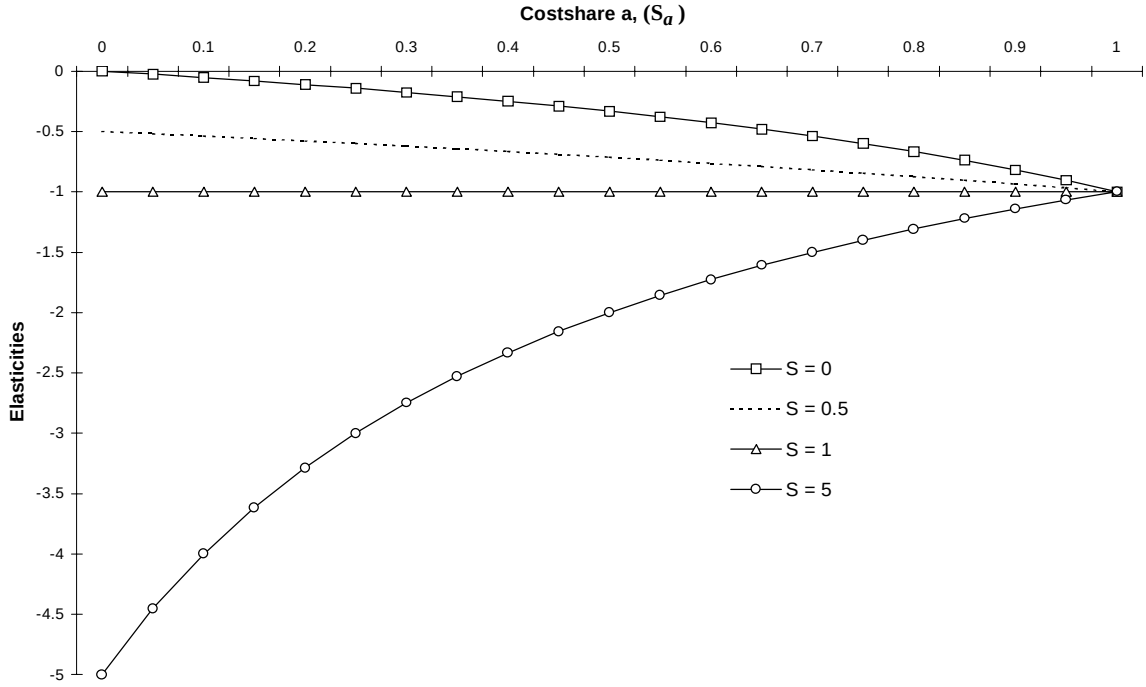


Panel b

mark-up rule to cover all fixed costs is therefore not unreasonable.[7] However, if this is the case, all marketing costs will be fixed costs. That this is indeed is common business practice can be seen in any introductory textbook in accounting, and the surveys conducted as part of this project, which relate to the seafood value chain, also indicate that mark-up rules are commonly applied (Guillotreau and Le Grel, 2001).

While a short-run technology with only one variable input factor in each production process does not seem unrealistic for many retailers or wholesalers, other factors such as labour and capital cannot be treated as fixed in the long run. It may therefore be of interest to see how the relationship between the consumer demand and the derived demand elasticities changes with different relationships between two cost shares. This is graphed in Figure 2.2 for four different values of the elasticity of substitution, σ = 0, σ = 0.5, σ = 1 and σ = 5. The consumer demand own-price elasticity η is set equal to minus one, and the supply elasticity for input *b*, e_b, is set equal to one.

Figure 2.2: The relationship between consumer and derived demand elasticities, S = σ.



The relationships in the figure are relatively insensitive to the supply elasticity for input *b*, and also to η if the relationship between η and σ is kept constant. In all cases, the derived demand elasticity approaches the elasticity of substitution when the cost share of input *a* approaches zero, and in all cases the derived demand elasticity

[7] We are here also assuming that there are no substitution between outputs, or that the intermediary's production technologies are non-joint so that there exists a separate production function for each output. This assumption is implicitly made in virtually all analyses of the relationship between retail and derived demand elasticities as only one good is considered, and when investigated also found to be reasonable (Wohlgenant, 1989). It also seems like a reasonable assumption, since one would not expect e.g. supermarkets to make large adjustments that goods are on the shelves based on changes in the relative prices of the goods.

approaches the consumer demand elasticity when the cost share of input *a* increases towards unity. The elasticities are equal when the cost share of input *a* is one. That the elasticities approach each other when the budget share of the primary good is higher, also implies that one gets closer to perfect price pass through, since the value of the possible substitution decreases.

That the derived demand elasticity will equal the consumer demand elasticity when one might regard the intermediaries' production technology as containing only one variable input factor is useful in empirical work. For the elasticities to be identical, the prices must be proportional, implying an elasticity of price transmission of 1.[8] This give us the opportunity to test this hypothesis using only price data, which are often much easier to obtain than quantity data, particularly at the retail level. The test performed is similar to tests for the Law of One Price, but with data at different levels in the marketing chain rather then from different markets.

2.4. Technological change

An important characteristic for many value chains is that there has been substantial technological innovation in distribution and logistics. The surveys conducted in this project certainly indicate that this has been the case in the seafood value chain (Guillotreau and Le Grel, 2001), and particularly so for salmon as production has increased. As it is likely that there is at least economies of scale locally in transportation, logistics and other marketing services, one would expect the margin to decline if technological change is present. However, practical considerations such as return freight may actually turn this relationship around. In general, it is a problem for freighters to find cargo when returning from remote areas, and hence rates are low. However, sufficient production of some commodity will change the direction in which empty cargo is a problem, and than the seafood producers will have to pay not only ordinary freight rates, but also to compensate the freighters for going in the other direction without cargo. This has been the case for many freight routes from Norway and Scotland. Hence, it is not entirely clear whether increased scale will lead to technological changes that increase or decrease the margin.

In the literature on technical efficiency one distinguishes between technologically neutral or non-neutral change (Kumbhakar and Lovell, 2000). In the case with only one variable input factor, which is the focus of interest here, this distinction will not matter as technological change will then always be neutral. Neutral technological change is normally modeled with a time trend, which is supposed to capture the systematic changes in the firm's operation due to technological change. The firm's problem can then be reformulated as

$$(13) \qquad \Pi(r, w, z, t) = py - C(y, w, z, t)$$

where *t* denotes the technological change. The first order condition then changes to

[8] This can most easily be seen in a double log demand function, where the estimated parameters are elasticities. If one changes the base of one of the prices, the only effect this has in the model is that the constant term changes. The elasticity is the same.

(13') $p = C_y(y, w, z, t)$

which then also varies with time. With only one variable input factor in this case, one will still have perfect price pass through even though the margin changes over time due to the technological change.

2.5. Pass-through with market power

In this discussion we will first present the problem of a monopolist, which is the market structure that gives most market power to a firm. The arguments extend to oligopolies with only minor modification to the qualitative results. The key feature of the market structure for a firm with market power is that it influences price by the quantity it produces. Hence, price is not only a scalar as in the competitive case, but a function of output, i.e. $p=p(y)$. The firm's problem then changes to maximizing

(14) $\Pi(r, w, z) = p(y)y - C(y, w, z)$

This gives the first order condition

(14') $p + p_y y = C_y(y, w, z)$

which can be written as the Lerner index

(14'') $\frac{p - C_y}{p} = \frac{1}{|e|}$

where e is the elasticity of demand.

The key observation with respect to price pass-through is that the monopolist will take both the quantity and price effect into account when responding to changes in production cost. The monopolist will therefore accommodate a cost change partly by changing the quantity supplied and partly by changing the price. The response will be similar to a change in demand. Hence, price pass-through will not be complete for a monopolist, and the elasticity of price transmission will accordingly be less then one.[9]

For an oligopolist the Lerner index is changed to

(15) $\frac{p - C_y}{p} = \frac{s_i}{|e|}$

where s_i is the market share of the ith firm. Relative to the monopolist, the firm's market power is reduced because of its lower market share, and if the market share becomes small the market power disappears as the margin approaches zero. When it comes to price pass-through, the arguments are similar to those for a monopolist. In

[9] There is one exception. In the very special case when the monopolist's production technology has constant unit cost and the demand faced by the monopolist has a constant demand elasticity, the margin will be constant (Genesove and Mullin, 1998).

an oligopolistic value chain, price pass-through will also in this case be less than perfect.

2.6. Information contained in prices

For intermediaries with only a single variable input factor, a test of whether the price transmission elasticity is equal to one will be a test for the null hypothesis of no market power at that level of the chain. However, the alternative is not clear as this hypothesis will be rejected both if the intermediaries are competitive, but applying more than one variable factor, and if the intermediaries have market power.[10] The information contained in prices at different levels in the value chain can therefore provide evidence for a competitive industry, but it is not straightforward to interpret the alternative.

Although the information contained only in prices therefore is limited we think it is of interest for at least two reasons. First, price data are much more available than cost and other market data that can better describe the intermediary's optimization problem. Hence, analysis will be possible in cases where one does not have sufficient information to use other approaches. Second, many industries, and particularly primary industries, have a structure where one factor, the primary good, is the main factor in the chain. This factor therefore strongly influences the use of other factors, and also often has a high budget share. Some examples of applications using only a single variable input factor or pointing to the dominance of a single factor are Toft and Bjørndal (1997), Genesove and Mullin (1998), Paul (2001) and Asche *et al* (2002). This assumption may therefore not be too restrictive in relation to many industries, and particularly primary product producers.

[10] This test is similar to tests for pricing to market in the international trade literature (Knetter (1993). However, in the international trade literature one avoid the multi-factor issue since export/import prices measure total cost.

3. Methodology

In this chapter we will look closer at the methodology used to investigate the relationships between prices at different levels in the value chain. We will first briefly comment upon the functional form. However, the primary focus of this section will be on econometric issues since a number of recent studies have indicated that most seafood prices are nonstationary (Bose and Mcilgrom, 1996; Gordon and Hannesson, 1996; Asche, Salvanes and Steen, 1997; Asche, Bremnes and Wessells, 1999; Jaffry, Pascoe and Robinson, 1999; Jaffry *et al*, 2000, Asche, 2001, Asche and Guttormsen, 2001).

3.1. Functional form

Throughout chapter 2 we worked with general functional expressions. However, these are not useful in empirical analysis and we must therefore assign specific functional forms to the relationships between prices. In the literature relationships that are linear in the variables or linear in the logarithms of the variable are the most common. Heien (1980) uses a functional form that is linear in the variables. This is consistent with a production technology with fixed proportions. However, with this functional form, one imposes proportional relationships, and with only one variable factor, also a proportional margin. We will therefore use a specification that is multiplicative, or linear in the logarithms. The advantage with such a specification is that proportionality is a testable hypothesis, and since this is nested in a more general model, the model will also be able to pick up other influences.

Let $P1$ be the price at the higher level in the chain and $P2$ at the lower level. The relationship between the prices at two different levels in the value chain can then be expressed as:

$$(1) \qquad P1 = \alpha P2^{\beta}$$

The parameter β gives the degree of nonlinearity in this relationship. If $\beta=0$, there is no relationship between the variables, and if $\beta=1$ the relationship between the variables is proportional with α as the coefficient of proportionality. The parameter α has a direct economic interpretation only if $\beta=1$ so that the relationship is linear. In that case α provides information about the mark-up. If $\alpha=1$, the prices are identical, while if $\alpha=1.1$, there is a 10% mark-up from P2 to P1. If β is not equal to one so that the prices are not proportional, the mark-up will vary with the levels of the prices, and can therefore only be estimated at given levels of the prices.

To make equation (1) linear, we take the logarithms of both sides. This gives

$$(2) \qquad \ln P1 = \ln \alpha + \beta \ln P2$$

Before estimation, an error term must be added. Since β is an estimated parameter, different hypothesis about the price transmission can be carried out on this parameter. In particular, the price transmission elasticity will be one if $\beta=1$. Technological change is introduced in this relationship by adding a trend *t*.

(2') $\ln P1 = \ln \alpha + \beta \ln P2 + \gamma t$

It is still the β parameter that is of interest, since this contains the information about the price pass through. However, as noted in section two the trend makes the actual mark-up nonconstant.

3.1.1. Live weight equivalents

At times seafood prices are reported in live weight equivalents, as there is often a substantial weight loss associated with processing. An extreme case is the difference between wet salted and dried salted cod, which is only the water content of the fish. As there are constant coefficients (Cofrepeche, 1996) for converting fish of one processing grade to live weight equivalents, this has the effect that the price is multiplied with a constant. Assume for instance that P1 is multiplied with *c*. Equation (2) then becomes

(3) $\ln P1c = \ln \alpha + \beta \ln P2$

However, since ln*ab*=ln*a*+ln*b*, this can be written as

(4) $\ln P1 = (\ln \alpha - \ln c) + \beta \ln P2$

Hence, converting prices to live-weight equivalents will only influence the constant term, and the mark-up if β=1. Prices in live weight equivalents do not take the substitution or market power effects and the price changes these may cause into account. One should therefore in general be careful when using these corrected prices with exception of the case when the value chain is competitive with only a single variable input factor.

3.2. Cointegration tests

Traditionally, relationships like equation (2) or its dynamic counterpart have been estimated with ordinary least squares (OLS).[11] However, since the late 1980s it has become evident that traditional econometric tools cannot be used when prices series are nonstationary, since normal inference theory breaks down (Engle and Granger, 1987). Instead cointegration analysis is the appropriate tool to infer causal long-run relationships between nonstationary time series.[12]

As noted above, most seafood prices are nonstationary. When data series are nonstationary, normal inference theory breaks down. A data series is said to be

[11] It may be of interest to note that the long-run relationship in equation (2) could be interpreted as a market integration relationship if the prices were measured at the same level in the value chain. This is of interest since the econometric approach used here is more common in that literature (e.g. Ardeni, 1989; Goodwin and Schroeder, 1991; Asche, Bremnes and Wessells, 1999).

[12] Cointegration methods have also recently been used when estimating relationships in the value chain (Asche et al, 1998; Cramon-Taubadel, 1998; Goodwin and Holt, 1999).

nonstationary when its mean and variance are not constant.[13] The cointegration approach may be represented as follows.[14] Consider the two price series, P_{1t} and P_{2t}. Each price series is by itself nonstationary and is required to be differenced once to produce a stationary series. In general, a linear combination of nonstationary data series will be nonstationary. In this case there is no long-run relationship between the data series. However, when the data series form a long-run relationship, the data series will move together over time, and a linear combination of the data series,

$$(5) \qquad P_{1t} - \Psi P_{2t} = \varepsilon_t ,$$

will produce a residual series ε_t which is stationary. In this case, the prices p_{1t} and p_{2t} are said to be cointegrated, with the vector $[1,\psi]$ as the cointegration vector (Engle and Granger, 1987). This is straightforward to extend to a multivariate case.

Two different tests for cointegration are commonly used in the literature. They are the Engle and Granger test (Engle and Granger, 1987) and the Johansen test (Johansen, 1988; 1991). We will here use the latter, as this is the most powerful test (Gonzalo, 1994) and allows parametric tests on the long-run parameters.

The Johansen test is based on a vector autoregressive (VAR) system. A vector, x_t, containing the N variables to be tested for cointegration is assumed to be generated by an unrestricted k^{th} order vector autoregression in the levels of the variables;

$$(6) \qquad \mathbf{x}_t = \Pi_1 \mathbf{x}_{t-1} + ... + \Pi_k \mathbf{x}_{t-k} + \Phi D_t + \mu + e_t$$

where each of the Π_i is a $(N \times N)$ matrix of parameters, μ is a vector containing a constant term, a trend if there is technological change and short-run variables that does not influence the long-run relationship like seasonality and $\varepsilon_t \sim niid(0,\Omega)$. The VAR system of equations in (6) written in error correction form (ECM) is;

$$(6) \qquad \Delta \mathbf{x}_t = \sum_{i=1}^{k-1} \Gamma_i \Delta \mathbf{x}_{t-i} + \Pi_K \mathbf{x}_{t-k} + \mu + e_t$$

with $\Gamma_i = -I + \Pi_1 + ... + \Pi_i$, $i = 1,...,k-1$ and $\Pi_K = -I + \Pi_1 + ... + \Pi_k$. Hence, Π_K is the long-run 'level solution' to (6), which will have the same structure as the relationship in equation (2). If x_t is a vector of $I(1)$ variables, the left-hand side and the first (k-1) elements of (7) are $I(0)$, and the last element of (7) is a linear combination of $I(1)$ variables. Given the assumption on the error term, this last element must also be $I(0)$; $\Pi_K x_{t-k} \sim I(0)$. Hence, either x_t contains a number of cointegration vectors, or Π_K must be a matrix of zeros. The rank of Π_K, r, determines

[13] For a more precise notion of the nonstationarity, nonstationary data series are often labelled depending on how many times they have to be differenced to yield a stationary data series. A data series that has to be differenced once to become stationary is said to be integrated of order one, denoted $I(1)$. Most economic data series seem to be integrated of order one.

[14] See e.g. Hendry and Juselius (2000) for a more thorough discussion about modelling of nonstationary data series and cointegration.

how many linear combinations of x_t are stationary. If $r = N$, the variables in levels are stationary; if $r = 0$ so that $\Pi_K = 0$, none of the linear combinations are stationary. When $0 < r < N$, there exist r cointegration vectors - or r stationary linear combinations of x_t. In this case one can factorise Π_K; $-\Pi_K = \alpha\beta'$, where both α and β are $(N \times r)$ matrices, and β contains the cointegration vectors (the error correcting mechanism in the system) and α the adjustment parameters. Two asymptotically equivalent tests exist in this framework, the trace test and the maximum eigenvalue test.

In a system with n data series one can at most find n-1 cointegration vectors (Stock and Watson, 1988). It then follows that all price series have the same stochastic trend, and accordingly are pairwise cointegrated. In theory, an equivalent approach to estimating a system to test for relationships in the value chain is therefore to test the relationships between all pairs of prices. If all pairs are found to be cointegrated, all prices contain the same stochastic trend, and one will expect to find n-1 cointegration vectors in the system. This may often be an advantage in applied analysis as one then reduces what Hendry (1996) labels the "curse of dimensionality". However, an issue in applied work might be which pairs to choose. With n prices, one can find n-1 cointegration vectors at most, but the variables can be organized as $(n^2\text{-}n)/2$ pairs. Hence, all but n-1 pairs will be redundant. A potential problem is therefore that one can obtain different conclusions depending on which pairs one chooses. In market integration analyses this problem is often avoided by choosing a leading price which all the other prices are then measured relatively to (Goodwin and Schroeder, 1991). However, although it is not possible in theory, in practice the different theoretically equivalent estimates may yield conflicting evidence. In our empirical analysis, we do not have a sufficient number of observations to estimate full systems with any confidence. We will therefore estimate the cointegration vectors in pairs. We will then adopt Goodwin and Schroeder's approach and in general choose a price in the value chain that all other prices are evaluated with respect to avoid redundant estimates of the same relationships. However, we will in some cases provide some redundant estimates when we feel that it gives stronger foundations for our results, or for expositional purposes.

The Johansen procedure allows hypothesis testing on the coefficients α and β, using likelihood ratio tests (Johansen and Juselius, 1990). In our case, it is restrictions on the parameters in the cointegration vectors β which is of most interest. More specifically, in our case there are two price series in the x_t vector. Provided that the price series cointegrate, the rank of $\Pi = \alpha\beta'$ is equal to 1 and α and β are (2×1) vectors. A test of whether the prices are proportional or if the elasticity of price transmission is equal to one is then formulated as a test of whether $\beta'=(1,-1)'$.

Also tests on the α vector are of interest. If a row in α contains only zeros (or in our case one element since α is a column vector), the price in question will be weakly exogenous. In this case, this price will determine the other price. A further discussion of these tests in a market delineation context, where they have very similar interpretations, can be found in Asche, Bremnes and Wessells (1999). This is of interest since weak exogeneity in the long-run implies that the price is determined at a specific level in the value chain by factors exogenous to the prices, and that the

movements in the other prices then is derived from this "leading" price. For instance if the retail price is weakly exogenous the value chain will be demand lead, while if the primary price is weakly exogenous the value chain will be pushed by the supply.[15]

[15] It may be of interest to note that the demand pull and supply push hypothesis are similar to the central market hypothesis in market integration tests (Goodwin and Schroeder, 1991; Asche, Bremnes and Wessells, 1999).

4. Data sources and time series properties of the data

4.1. The cod value chain in Norway and Portugal

In Table 4.1, the data series used in the analysis of the value chain for cod between Norway and Portugal is provided together with Dickey-Fuller tests. The data series are at a monthly frequency, and we have data for the ex. vessel price in Norway, Norwegian export prices for different product forms and the retail price for dried salted cod in Portugal. As will be further discussed in Chapter 5, all cod is consumed as dried salted in Portugal, and hence this will be the retail price for all product forms. Also, we do not have Portuguese wholesale prices for any of the product form, but assume that import prices can be used as proxies as imports compete on all levels in the value chain.

As shown in chapter 3, the time series properties of the data are important with respect to the statistical method used. This is investigated with Dickey-Fuller tests. The results are reported in the last four columns of Table 4.1. The lag length in the stationarity tests was set to make the error terms in the augmented Dickey Fuller tests white noise. It is worth noting that the conclusions with respect to stationarity are independent of the lag length chosen. All price series are found to be nonstationary, and cointegration analysis will therefore be the appropriate tool.

Table 4.1: Data sources and time series properties for price series in the cod value chain in Norway and Portugal

Type of series	Period	Source	ADF test levels (constant included)	ADF test levels (constant and trend)	ADF test first differences (constant included)	ADF test first differences (constant and trend)
Ex Vessel Price, Norway	1988-1999	Norwegian Rawfish Organization	-0.426	-0.719	-5.482**	-5.600**
Export price, salted cod, Norway	1988-1999	Statistics Norway	-1.167	-1.271	-5.221**	-5.301**
Export price, frozen cod, Norway	1988-1999	Statistics Norway	-0.525	-0.845	-4.173**	-4.177**
Export price, Dried salted cod, Norway	1988-1999	Statistics Norway	-0.567	-0.752	-5.534**	-5.731**
Retail price, dried salted cod, Portugal	1988-1999	Institute of National Statistics	-1.154	-1.271	-3.488*	-3.541*

* indicates significant at a 5% level, and ** at a 10% level

4.2. The value chain for frozen cod in the United Kingdom

Table 4.2 gives a statistical description of the data used to analyse the frozen cod value chain in the UK. The price data was collected on monthly basis.

In order to avoid spurious regression results, the properties of the time series are investigated with the augmented Dickey-Fuller (ADF) tests, the results of which are reported in the last four columns of Table 4.2. The ADF test was performed on the price series and its first difference to determine the level of integration of each series. Rejecting the null hypothesis in the ADF test indicates the presence of unit root and therefore non-stationarity.

Table 4.2: Data sources and time series properties for price series in the frozen cod value chain the United Kingdom

Type of series	Period	Source	ADF test levels (constant included)	ADF test levels (constant and trend)	ADF test first differences (constant included)	ADF test first differences (constant and trend)
Import price, whole	1992-1999	SFIA	-1.81	-2.90	-10.967**	-10.93**
Retail price, fillet	1992-1999	SFIA	0.86	-2.76	-9.62**	-10.09**
Wholesale price, fillet	1995-1999	SFIA	-0.69	-3.02	-11.83**	-7.14**

** Indicates significant at 1%, * indicates significant at 5%. Test without trend critical values are 5%=-2.916, and 1%=-3.555. Test with trend included, critical values are 5%=-3.494, 1%=-4.135

The ADF results suggest that we cannot reject the null hypothesis of a unit root at the 1% significance level for the levels of the variables. Applying the ADF test on the first difference allowed us to reject the null hypothesis. Therefore, we take the results to indicate that the levels of the variables are integrated of order one, I(1). Having established the stationarity of the series, we can proceed with examination of price relationships at different level of the cod value chain.

4.3. The salmon value chain in the United Kingdom, Norway, France and Finland

The salmon market in Europe is one of the biggest in the world and the interactions along the value chain provides and even more complex situation than in the case of cod. The length and data sources for the price series used in this analysis are listed in table 4.3. The time series properties of each price series are also presented in this table (i.e. tests for stationarity). All time series presented are monthly. The length of time over which the stationarity tests are conducted for each price series is for the longest time period used in the study. Often the price series will be analysed over shorter periods than this given constraints in the length of the other price series being analysed. In addition, it is often the case that data was available over a longer time period for some price series, but again, the length of other series to be included in the analyses was a limiting factor. The lag length in the stationarity tests was set to make the error terms in the augmented Dickey-Fuller tests white noise. It is worth noting that the conclusions with respect to stationarity are dependent on the lag length choosen and there is a tendency at lower lags that some of the series are stationary.

Table 4.3: Data sources and time series properties for price series in the salmon value chain

Type of series	Period	Source	ADF test levels (constant included)	ADF test levels (constant and trend)	ADF test first differences (constant included)	ADF test first differences (constant and trend)
Farm gate price salmon UK	1990-1998	MAFF, DANI, SERAD	-1.19	-2.62	-5.98**	-5.95**
Retail price whole fresh salmon UK	1992-1998	SFIA	-0.83	-1.49	-4.94**	-4.86**
Retail price fresh salmon fillets UK	1992-1998	SFIA	-1.86	-1.91	-7.86**	-7.84**
Retail price fresh salmon steaks UK	1992-1998.	SFIA	-1.77	-1.96	-7.91**	-7.86**
Retail price smoked salmon UK	1992-1998.	SFIA	-1.45	-2.97	-4.13**	-4.10**
Export price fresh salmon UK	1990-1998	MAFF	-0.87	-2.20	-4.89**	-4.86**
Export price smoked salmon UK	1990-1998	MAFF	-4.46**	4.53**	-7.38**	-5.51**
Wholesale price fresh salmon France (origin Scotland) [1]	1990-1998	SNM, Rungis	-2.09	-3.19	-6.32**	-6.27**
Wholesale price fresh salmon France (origin Norway) [2]	1993-1999	SNM, Rungis	-1.96	-2.11	-6.17**	-6.28**
Export price smoked salmon France [3]	1990-1998	French customs	-3.20*	-4.07**	-6.45**	-6.39**

Table 4.3 continued: Data sources and time series properties for price series in the salmon value chain

Type of series	Period	Source	ADF test levels (constant included)	ADF test levels (constant and trend)	ADF test first differences (constant included)	ADF test first differences (constant and trend)
Retail price whole fresh salmon sold through supermarkets France	1990-1998	OFIMER	-1.19	-1.92	-4.06**	-4.07**
Retail price fresh salmon fillets sold through supermarkets France	1990-1998	OFIMER	-2.42	-4.05*	-5.97**	-6.11**
Retail price whole fresh salmon sold through other retail outlets France	1990-1998	OFIMER	-2.30	-2.40	-9.65**	-9.64**
Retail price fresh salmon fillets sold through other retail outlets France [4]	1990-1998	OFIMER	-2.16	-2.24	-4.98**	-5.00**
Retail price smoked salmon sold through supermarkets France	1990-1998	OFIMER	-1.59	-1.46	-3.91**	3.98*
Retail price smoked salmon sold through other retail outlets France	1990-1998	OFIMER	-3.57**	-3.75*	-9.59**	9.54**
Farm gate price salmon Norway	1993-1999	NSL	-1.96	-1.23	-6.24**	-6.47**
Import price whole fresh salmon into the UK from Norway [5]	1992-1998	MAFF	-1.37	-1.65	-8.27**	-8.21**
Export price whole fresh salmon from Norway to France	1993-1999	Norwegian Trade Statistics	-2.02	-1.10	-3.84**	-4.16**
Export price whole fresh salmon from Norway to Finland	1995-1999	Norwegian Trade Statistics	-1.30	-2.12	-2.70	-4.72**
Import prices salmon from Norway to Finland [6]	1995-1999	Finnish board of customs	-1.76	-2.49	-4.96**	-4.98**
Ex-farm price of salmon trout in Finland [7]	1995-1999	Finnish Fish Farmers' Association	0.23	-1.52	-2.16	-4.68**
Wholesale price of whole fresh salmon trout in Finland [8]	1995-1999	Finnish wholesale companies	0.22	-2.63	-5.34**	-6.01**
Wholesale price of whole fresh salmon in Finland [9]	1995-1999	Finnish wholesale companies	-2.22	-2.32	-2.90	-4.79**

Table 4.3 continued: Data sources and time series properties for price series in the salmon value chain

Type of series	Period	Source	ADF test levels (constant included)	ADF test levels (constant and trend)	ADF test first differences (constant included)	ADF test first differences (constant and trend)
Wholesale price of fresh salmon fillets in Finland [10]	1995-1999	Finnish wholesale companies	-3.86**	-3.82*	-4.51**	-4.45**
Retail prices salmon trout Finland [11]	1995-1999	Statistics Finland	-0.85	-2.50	-4.85**	-4.90**
Campaign prices salmon trout Finland [12]	1995-1999	Finnish Fish Farmers' Association	-0.69	-2.64	-2.46	-5.23**

** Indicates significant at 1%, * indicates significant at 5%.

Notes: 1. Whole fresh salmon (3-4kg) from Scotland. 2. Whole fresh salmon (3-4kg) from Norway. 3. Smoked salmon fillets. 4. Fillets refers not only to fish which is filleted, but also to steaks and portions, i.e fish that is 'cut'. 5. Import prices for salmon from Norway to the UK are used as a proxy for export prices for salmon from Norway to the UK. 6. and 7. Production and import prices are quantity weighted monthly means. Import prices include cost, insurance and freight. 8. 9. and 10. Wholesale prices are an arithmetic mean of prices collected from five national wholesale and processing companies (50 per cent of wholesale volume in Finland). 11. Retail prices are an arithmetic mean of prices collected from 2000 food stores around Finland by Statistics Finland. 12. Campaign prices are collected from newspapers by Finnish Fish Farmers Association.

There are four instances where the null hypothesis of stationarity in the levels of prices cannot be rejected indicating that the price series in question are stationary in their levels (table 4.3). The first is for export prices of smoked salmon from the UK, the second is for export prices of smoked salmon from France, the third is for smoked salmon sold through other retail outlets in France and the fourth is for wholesale prices of fresh salmon fillets in Finland. Despite this, we will include the series in our analysis treating the results with caution and noting any possible inconsistencies that might arise.

5. The value chain for cod between Norway and Portugal

Norway has for a long time been among the leading seafood exporters in the world. In value terms commercial fishing represents about two thirds of total Norwegian seafood production, with the remaining one third coming from aquaculture. While a single species, salmon, is dominating the farming sector, in commercial fishing there is a much more diverse range of species that are harvested. Still, some species are more important than others in the harvesting sector, and cod is the largest species in the fisheries measured by value and sometimes also as measured by quantity. Moreover, while salmon farming is a new industry that has been commercially significant only during the last two decades, cod (*Gadus morhua*) has been among the leading export products from Norway for a millennium, and at times has made up more than 50% of total Norwegian export value.

Until the 1930s, virtually all cod exported from Norway was either dried salted cod or dried cod. These two product forms had been the two main product forms for centuries, since this was the only known preservation technologies for cod at the time. The main difference between them is that for dried cod, the raw fish is dried directly, while for dried salted cod, the fish is first salted and then, possibly after some time, dried. Moreover, as the drying process removes virtually all moisture from the fish, this also made it lighter, and therefore easier to transport. However, it must be noted that water has to be reinjected into the fish before consumption. As transportation and preservation technologies became better in the 1930s, it became possible to export salted cod, as well as the new product forms based on frozen cod.[16] At the global market, frozen cod became the main product form. However, fish produced with traditional preservation methods, dried, dried salted and salted cod still have substantial markets, and in contrast to Canada, Iceland and Russia these product forms continue to be important in Norway. During the last decade, they made up about 50% of Norway's cod exports. The markets for these products have mainly been in southern Europe and Latin America. During the last decade the most important market has been Portugal for both dried salted and salted cod.[17]

Fish and seafood has for a long time been an important component of the diet in Portugal, with an average annual gross consumption *per capita* of over 60 kg. This makes Portugal the country with the highest seafood consumption in the EU, and the seventh highest *per capita* consumption in the world. A substantial part of this consumption is dried salted cod, which is either imported directly as a processed product, or produced in the Portuguese dry salting industry using other forms of imported cod.

The foundation of dried salted cod consumption in Portugal dates back to, approximately, the end of the 15th century, when the Portuguese discoveries were at their peak. The cod, caught in the banks of Terra Nova (Grand and Georges Banks), was submitted to a double process of preservation: onboard salting and inland drying.

[16] In some markets like Spain, salted cod has taken over the market from dried product forms, in some markets like Italy all types of products are consumed, while in other markets like Portugal, dried salted cod are preferred.

[17] The share of dried cod has decreased substantially during the last 50 years and now makes up only about 5% of cod production. Most of this is exported to Italy.

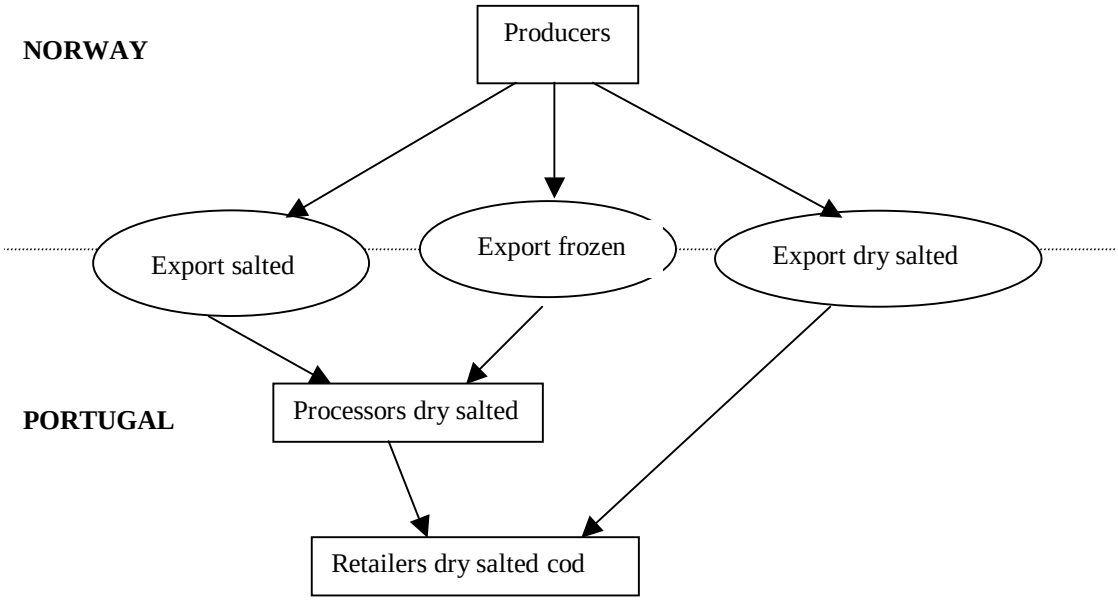
The salting of the scaled cod was a rather cheap and expedited process to store onboard the cod caught in Terra Nova. The drying onshore allowed the storage of cod for long periods.

The cod salting and drying industry is the only significant sector in salting, drying, and smoking of fish in Portugal. Until the late 1970s, it was an integrated industrial activity, highly dependent on catches made by the national long distance fishing fleet. The industrial plants belonged, in general, to the ship-owners and were mainly located near the long distance ports, especially in Aveiro. The changes in international maritime jurisdiction with the 200 miles EEZ contributed to the collapse of the Portuguese long distance fleet and to the disintegration of the salting and drying plants. These units then had to rely almost exclusively on imported raw material. On the top of this, the fisheries agreement maintained between Portugal and Canada was denounced by that time, and the catching quotas of cod in the NAFO area were substantially cutback.

From the mid 1980s, most of the cod consumed in Portugal has therefore been imported. Portugal is the world's largest importer of dried salted cod, which outside of Portugal is produced virtually only in Norway. In addition, Portugal is a big importer of salted cod, which is dried in Portugal before consumption. This cod comes from all the larger harvesting nations, i.e. Canada, Iceland, Norway, Russia and small quantities from other places. In the 1990s, imports of frozen cod took market share from salted cod as the Portuguese industry thaws, salts and dries this input.

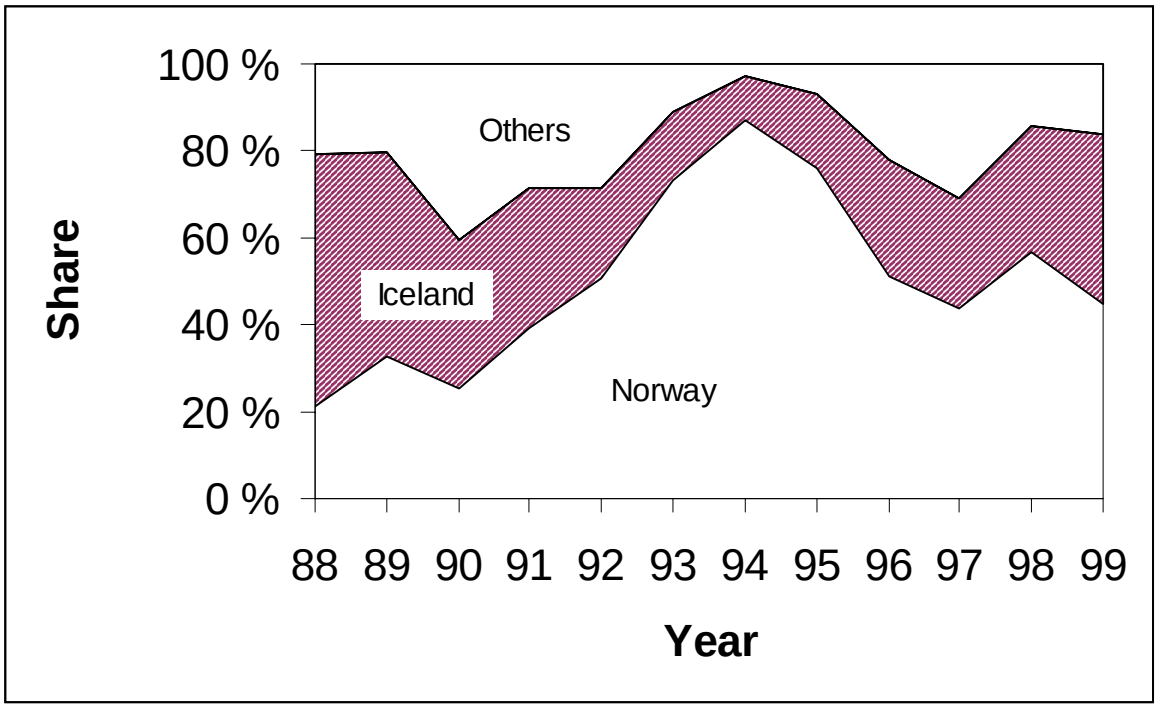
The main structure of the value chain for cod between Norway and Portugal is illustrated in Figure 5.1. The value chain is somewhat special as the final product, dried salted cod is produced only in Portugal and Norway, while the main input factor, cod, is available from many different sources. Cod is also imported to Portugal in different processed forms as an input for the Portuguese salting and drying industry. There is little doubt that there is a highly competitive global market for frozen cod (Gordon and Hannesson, 1996). Given the large number of suppliers it is also likely that this is the case for the market for salted cod. Moreover, although dried salted cod is produced only in two countries, there are many small companies in the industry in both countries (Guillotreau and Le Grel, 2001) giving little scope for market power. Market integration analysis and investigation of substitution relationships between different product forms of cod also indicate that the different cod markets are highly related (Gordon, Hannesson and Bibb, 1993; Asche, Gordon and Hannesson, 2001). This is as expected given that the budget share of the raw fish is high for all product forms (Toft and Bjørndal, 1996).

Figure 5.1: The cod chain between Norway and Portugal



For salted cod we use only Norwegian data. It may therefore be worthwhile to look briefly at the sources for salted cod. This discussion is based on Menezes *et al* (2001) and a more detailed discussion with test statistics etc. can be found there. The import shares are shown in Figure 5.2. As one can see, Norway and Iceland are the main sources with a combined market share of about 80% although with substantial variation between these two sources. In the others category, Canada is the most important source until the early 1990s when their cod stocks collapsed. From the mid 1990s, Russia entered as a source for salted cod and made up most of the others share then. Since the composition of the others category shifts over time it is hard to construct a consistent time series, in particular as there are several missing observations (on a monthly basis) even for others as an aggregate. Market integration analysis has therefore been conducted only between Icelandic and Norwegian salted cod. This should not be a great limitation given these two suppliers dominating position. The results indicate that the Law of One Price holds and therefore that the marked is highly integrated. This implies that Portuguese processors regard inputs from these two sources as equivalent, and will choose whatever is available. It also implies that we can interpret the Norwegian export price as the import price of salted cod in Portugal.

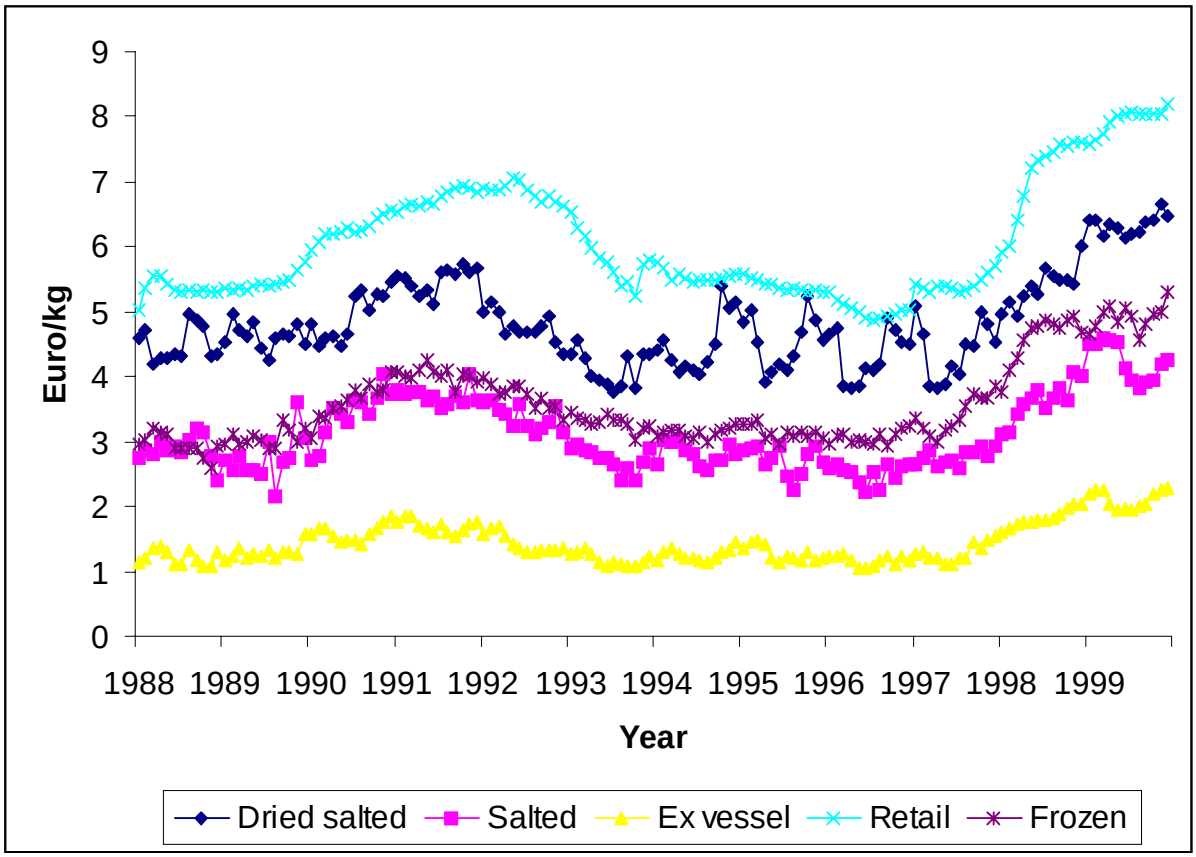
Figure 5.2: Import sources for salted cod to Portugal



In our analysis we have data on prices for the period January 1988 to December 1999. We use Norwegian ex-vessel prices, and the Norwegian export price to Portugal. We do not have wholesale prices for dried salted cod in Portugal. However, as dried salted cod is a relatively homogenous product, the price the Norwegian exporters receive should be a good proxy for the price the Portuguese producers obtain. Frozen cod is a relatively new product in this value chain, and there are a number of zero observations both for the Norwegian export price to Portugal, and for the total imports price to Portugal. Since there seems to be a well integrated global market for frozen cod (Gordon and Hannesson, 1996), we therefore use the Norwegian export price to all destinations as a proxy for the world market price. This should be a good measure for the price at which Portuguese importers could purchase frozen cod also in the periods when they actually did not. Finally, we have an average retail price in Portugal, which we assume is the consumer price for all dried salted cod in Portugal.

The price series are graphed in Figure 5.3, and basic descriptive statistics can be found in Table 5.2. The price increases substantially at each level in the chain with exception for frozen and salted cod (figure 5.3). The reason for this is the weight difference due to the different preservation technologies. This disappears if we recalculate the prices in live-weight equivalents (see Table 5.3). It is apparent from the figure that the main trends in the prices are similar, but that there is substantial short-run variation.

Figure 5.3: Prices in the Norway-Portugal value chain for cod



To investigate the exact structure of the relationships along the value chain, we estimated the long-run relationships with Johansen's method as described in chapter 3. In Table 5.1 we summarise the outcomes of the test, while the test statistics are reported in Appendix 1. The first thing to note is that, as expected, all prices are cointegrated so that they form long-run relationships. Furthermore, all prices are found to be proportional so that the elasticity of price transmission is one between all levels in the chain. This indicates that the margin is constant, and that the industry is highly competitive. In the final column, we test for weak exogeneity. The results indicate that the retail price in Portugal is exogenous to the salted price. With a *p*-value of 0.0105, there is also some evidence that the retail price is exogenous to the ex. vessel price, although this hypothesis is rejected at a 5% level. Neither retail nor dried salted cod prices are exogenous in that relationship. These results give weak evidence of price leadership for dried salted cod in this value chain. However, in the relationship between retail prices and frozen cod prices, frozen cod is found to be weakly exogenous. As frozen cod is also the most important product form globally, this suggests that it is the global cod market, or possibly whitefish market, that determines the price in Portugal.

Table 5.1: Overview of results from the cointegration analysis

Price 1	Price 2	Cointegration	Proportionality	Exogenous price
Retail	Ex-vessel	Yes	Yes	Neither
Retail	Salted	Yes	Yes	Retail
Retail	Dried salted	Yes	Yes	Neither
Retail	Frozen	Yes	Yes	Frozen

Given the substantial price differences shown in Figure 5.2, it may be of interest to investigate the margins with more scrutiny. In Table 5.2 we report descriptive statistics for the product prices and mark-ups relative to the ex-vessel price, while in Table 5.3 we report the prices in live weight equivalents and again the associated mark-ups. From Table 5.2 we can see that the mark-up from the ex-vessel price to salted cod is 117% or more than a doubling of the price. This mark-up is almost the same for frozen cod, but increases substantially again to the export price of dried salted cod. Finally the mark-up is 321% from the ex-vessel to the retail price, or a trebling of the price. The mark-up then makes up 76.2% of the retail price or about three quarters of the total value of the product. Depending on where the product is processed, a substantial part of this mark-up will fall to Norwegian or Portuguese processors. About 80% of the value in the chain falls to Norwegian processors when they export dried salted cod, while about half the value fall to Portuguese processors and retailers when the fish is imported as salted.

Table 5.2: Descriptive statistics and margins (values in Euros/kg)

Price	Mean	Standard deviation	Mark-up in Euro	Mark-up in percent	Coefficient of variation percent	Proportionality
Ex-vessel	1.44	0.31			21	Yes
Salted	3.12	0.56	1.68	117	18	Yes
Frozen	3.56	0.65	2.12	146	18	Yes
Dried salted	4.83	0.68	3.38	234	14	Yes
Retail	6.07	0.89	4.63	321	15	Yes

This picture is substantially changed when we look at the prices in live weight equivalents in Table 5.3. The mark-up from fish at the ex-vessel level to salted fish is then as low as 7% and for dried salted cod it increases to only 15%. The reason for

this is that the processing to a large extent changes only the weight of the fish. In particular, the difference between dried salted and salted cod is basically the water contents. The processors add little value to the product with simple processing technologies. It is therefore not surprising that they have narrow margins. These low returns also indicate that the cost share for the primary product input, cod, is high, and hence that the process is neither very labour intensive nor capital intensive. This also indicates that whether the fish is processed in Norway or Portugal does not matter that much with respect to value added, as this is small anyway. The retailers obtain a slightly higher margin, as the price is up 46% from the ex-vessel level. However, this is reduced to 27% relative to the price of dried salted cod. Hence, one cannot say that the margin is very high for the retailers.

Table 5.3: Descriptive statistics and margins when prices are measured in live weight equivalents (values in Euros/kg)

Price	Mean	Standard deviation	Margin in percent
Ex vessel	0.97	0.22	
Salted	1.04	0.21	7.35
Frozen	1.03	0.20	6.18
Dried salted	1.12	0.18	15.67

It is conventional wisdom in most primary product markets that prices are most volatile at the primary level, and that they tend to get less volatile as one moves up in the value chain. As noted in chapter 2, this is consistent with an elasticity of price transmission of less the one. To investigate the volatility of the different prices in the value chain considered here, we computed coefficients of variation for the different prices. As one can see, these confirm the conventional wisdom also in this value chain, although the differences in volatility are not very large and basically equal between the export price of dried salted cod and the retail price. The coefficients of variation are a short-run measure, and are therefore not inconsistent with long-run elasticities of price transmission of one. The differences in volatility indicate that the short-run price transmission is not perfect, and hence that there are adjustment costs in this value chain. This is not unreasonable since the bulk of the Norwegian cod landings are in late winter and early spring, and there will accordingly be at least some storage costs associated with the product either at an intermediate level as salted or frozen fish, or as a final product. Moreover, industry sources also indicate that because of the many small firms in the business, there is considerable uncertainty with respect to how large these stores are at any point in time.

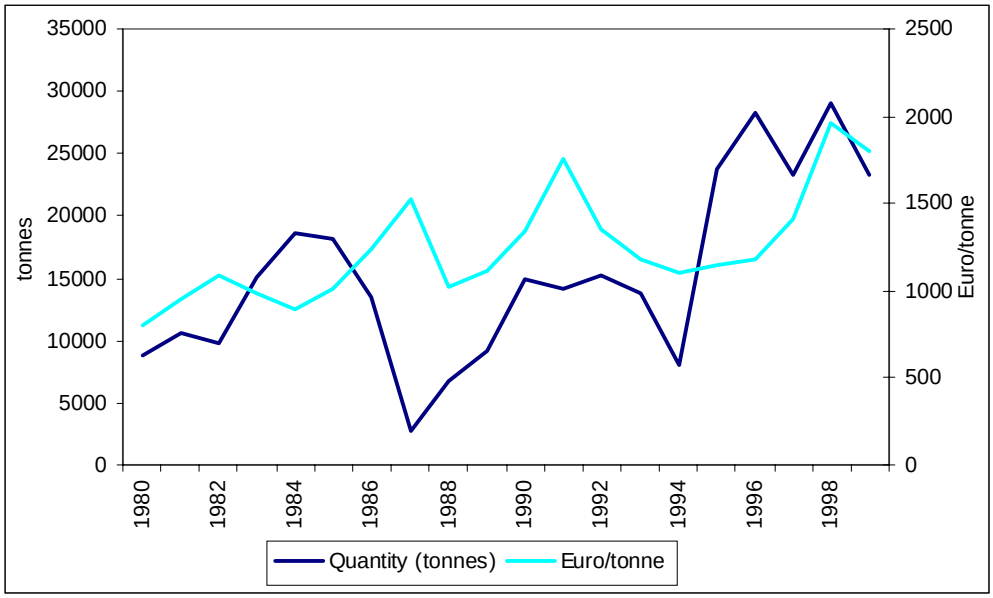
We can conclude that the value chain for cod between Norway and Portugal is highly competitive. The price pass-through is perfect in the long-run, but adjustment costs means this process takes some time. This leads to a somewhat higher variability of the prices upstream than for the prices downstream in the chain. The main determinant of

prices in the chain is the global price for frozen cod products. Hence, the trade with cod between Norway and Portugal seems to be a part of the global market for cod.

6. Frozen Cod Chain in the United Kingdom

The UK fishing industry is extremely diverse with large demersal, pelagic and shellfish fleets in operation. However, the demersal (whitefish) fleet, has always been the most important sector. In 2000 it accounted for 53% and 63% of the industry respectively by volume and value (DEFRA 2001). Within the demersal sector, and industry overall, cod is the most important species. It is the traditional favourite food fish in the UK[18], and was once abundant in the North Sea. In 1969 domestic landings of cod represented 43% of volume and 47% of value from all fish landings (Tait 1972), but by 2000 the relative importance of cod in the domestic catch was down to 11% and 19% respectively. While substitution possibilities exist, i.e. haddock, saithe and pollock, domestic landings of these species are also in decline. As a result the UK has been steadily increasing its reliance on imports of cod (and its substitutes). In the period between 1980 and 1999 the import quantity of whole frozen cod more than doubled as is shown in figure 6.1. Indeed, whole frozen cod and frozen cod fillets now dominate the supply of cod to the UK market, accounting for 59.5% and 69.5% of the market by volume and value[19]. It is for this reason that we shall concentrate on frozen imports as the point of origin in the UK cod chain.

Figure 6.1: Frozen cod (whole) import quantity and value (1988 – 2000)



In order to qualify our empirical approach a survey of fish processors, wholesalers and retailers was undertaken. Responses were used to identify the structure of the chain and the extent to which changes in cod supply has affected the industry.

The UK is becoming increasingly dependent on imports for cod supply (figure 6.1). The most important suppliers of cod to the UK are Iceland, Norway, the Faeroe Islands and Russia. The level of vertical integration in the marketing chain is

[18] Except in Scotland
[19] This figure does not account for live weight equivalents in other import data

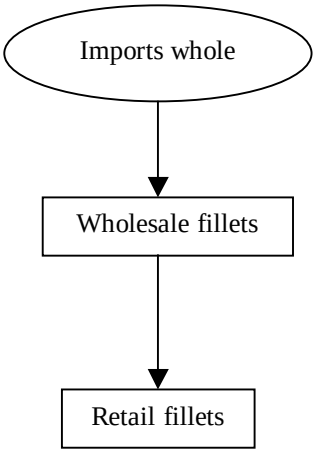
becoming more apparent as frozen import quantities increase. Processing firms, or indeed retailers, are taking over the role of wholesalers and specialised import firms in arranging international orders. It was in fact international trade, and the increasing dominance of supermarkets in food retail, that were sited as the most important factors affecting the processing and wholesale industries.

In order to cope with large import quantities, and adapt to supermarket needs, the average size of agents along the chain (processors, wholesalers', distributors) has been increasing. This growth, however, has been at the expense of smaller intermediaries that supply independent outlets. As such the number of firms involved, and jobs created, along the chain have fallen. This has had serious consequences for the traditional fishing areas of Grimsby and the NE of Scotland. The link between wholesale and fishmonger is now much less important as the supermarket to processor interaction now dominates the cod supply to retail. The processing sector can be loosely split into primary (1^o) and secondary (2^o) processing, though many firms do both (Guillotreau and Le Grel 2001).

Another important finding from the survey was that frozen and fresh fish products are treated quite differently. For example, major retailers purchase fresh fish and other fresh meats together, but purchase frozen fish through a different department. This approach has obvious benefits, as the storage and handling requirements of the two goods are quite different. It is in fact the case that once the fish is frozen its treatment and marketing will become more akin to frozen foods in general than other fresh fish products. This distinction is more important now that the retail sector has become concentrated in the hands of small number of supermarket chains as opposed to small fishmongers. In 1982, Supermarkets accounted for only 10% of the whitefish market (Fish Industry Forum, 1998) but by the end of 1998 their market share had risen to nearly 68% (Mintel, 2001). These supermarkets are generally supplied by a small number of processing firms, though there is some evidence of supermarkets themselves organising cod imports.

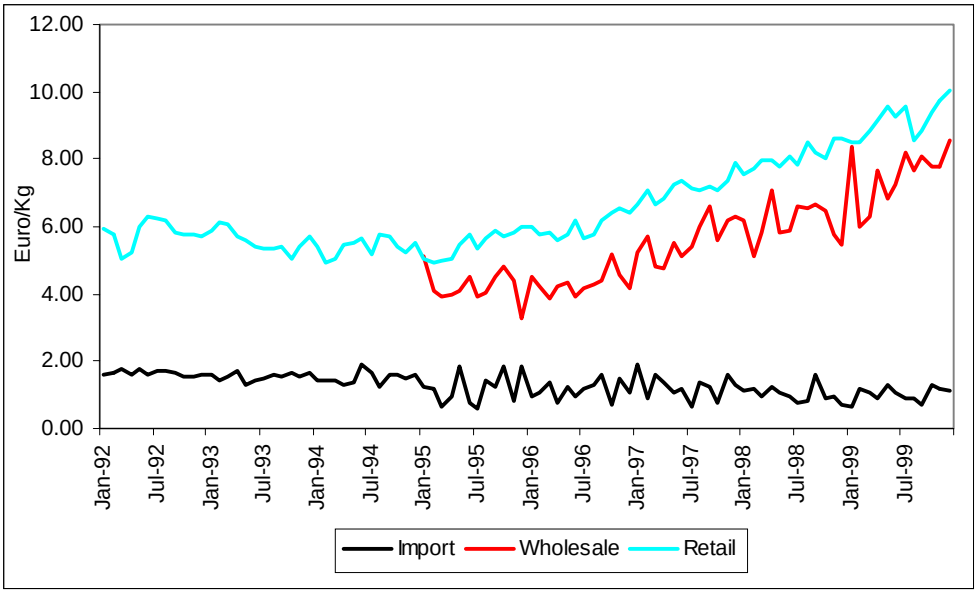
In this section the value chain for frozen cod products are investigated using price data from imports (whole), wholesale (fillet) and retail (fillet) levels. The main structure of the value chain is shown in figure 6.2.

Figure 6.2: The frozen cod chain in the United Kingdom



The price series are graphed in figure 6.3. While there is clearly some short run variation in the series, wholesale prices seem to follow a similar pattern to both import and retail prices, though import and wholesale prices do appear to deviate after January 1997.

Figure 6.3: Monthly frozen cod prices (1992 – 1999)



The existence of a long run relationship between the price series was investigated using Johansen's technique (see chapter 3). A summary of the results from cointegration, proportionality and exogeneity tests are given in Table 6.1, while more detailed test statistics are reported in Appendix 2. The results show that both price pairs are cointegrated and proportional, reflecting the degree of co-ordination between stakeholders in the industry. Proportionality implies that the law of one price (LOP) is supported in the tested relationship. The LOP suggests that the price differential or

spread between markets does not exceed transfer costs and it holds information about the mean difference between prices (Asche et al, 2000). It follows that the value chain considered here is highly competitive and that price changes are transmitted efficiently through the chain. Results from the survey confirmed this competitive market description, respondents stressed that when fish is frozen the extra storage time created allows traders to plan their sales. Williams and Wright (1991) have also shown that the interaction of trade and storage usually reduces price volatility and frequency of trade. As a result, trade flows for frozen fish are more stable and predictable and the frozen cod value chain is therefore relatively efficient.

Table 6.1: Overview of results from cointegration analysis

Price 1	Price 2	Cointegration	Proportionality	Exogenous Price
Import Whole	Wholesale Fillet	Yes	Yes	Wholesale
Retail Fillet	Wholesale Fillet	Yes	Yes	Wholesale

Granger causality tests indicate that wholesale prices are statistically influential at all stages of the marketing chain. Exogeneity in these prices may be derived from wholesalers' central role in the supply of cod. In order to maintain supply, large wholesalers may keep up to 3 months stock in storage[20] but this will vary as import orders must be placed before onward sales have been confirmed. Wholesalers typically obtain supplies from both domestic and international markets and generally offer fish retailers a wide choice of products, and with stored frozen fish they can maintain supply in periods of shortage. In this way they exercise some power over the market and dampen variations in supply.

Table 6.2: Descriptive statistics and margins

Price	Mean	Standard Deviation	Margin in Euro	Margin in percent	Coefficient of variation percent	Proportionality
Import	1.70	0.55			32	Yes
Wholesale	5.51	1.02	3.81	224	19	Yes
Retail	7.14	1.44	1.63	30	20	Yes

Descriptive statistics of series in the frozen value chain are presented in table 6.2. The margin from import to wholesale is 224% while the margin between wholesale and retail level is only 29%. However, when prices are measured in live-weight equivalents (l.w.e) the price per kg falls as the weight of the whole (unprocessed) fish is accounted for. Descriptive statistics in l.w.e. are given in table 6.3. The import price

[20] Findings from industry survey

decrease represents the change from heading and gutting of fish in the country of origin. Changes in the mean price at wholesale and retail levels account for weight loss from heading, gutting and filleting, which can be up to 60%. The difference in prices may be equivalent to the value added by processors on whole imported cod. Margins evaluated in l.w.e. terms between wholesale and retail remain unchanged as there is neither a weight or nor any value added between the two points, however the import –wholesale margin falls to 89%. In spite of the change, a higher margin is applied by wholesalers than retailers. This may reflect some of the costs associated with initial receipt, grading, storage and onward distribution of large volumes of frozen fish. Supermarkets, though, accept none of the costs associated with delivery and are only responsible for the fish when it reaches their depot doors. They sell a wide range of products and a recent competition enquiry showed that they only seek to make small margins on each of their products.

Table 6.3: Descriptive statistics and margins with prices in liveweight equivalents

Price	Mean	Standard deviation	Margin in percent
Import	1.12	0.36	
Wholesale	2.12	0.39	89
Retail	2.75	0.55	30

In order to examine price volatility the coefficient of variation has been reported in table 6.2. The coefficient of variation is the ratio of the variables standard error to its mean value expressed as a percent. A value of 1% suggests a low level of variance, perhaps due to sampling error, while a value of 50% indicates that the series is very imprecise[21]. The coefficients of variation reported in table 6.2 suggest that the cod price at import is more variable than at wholesale and retail. Import price variability may be associated with scarcity of the species, and the effect of storage by wholesalers as they import at an inconsistent rate as dictated by domestic demand. It may also be associated with the notion that upstream prices for primary products tend to be highly variable, but that this variability decreases as we move down the chain.

Cointegration analysis and proportionality tests indicate that efficient arbitrage appears to take place in this value chain. These results further support the notion that the frozen cod chain in the UK is part of a global market for cod. This may be attributed to the fact that increased shelf life of a potentially highly perishable product enables it to be stored and respond to market signals better. The margin between import and wholesale prices is significantly higher than the margin between retail and wholesale prices because of higher operating costs and increased price variability at upstream levels.

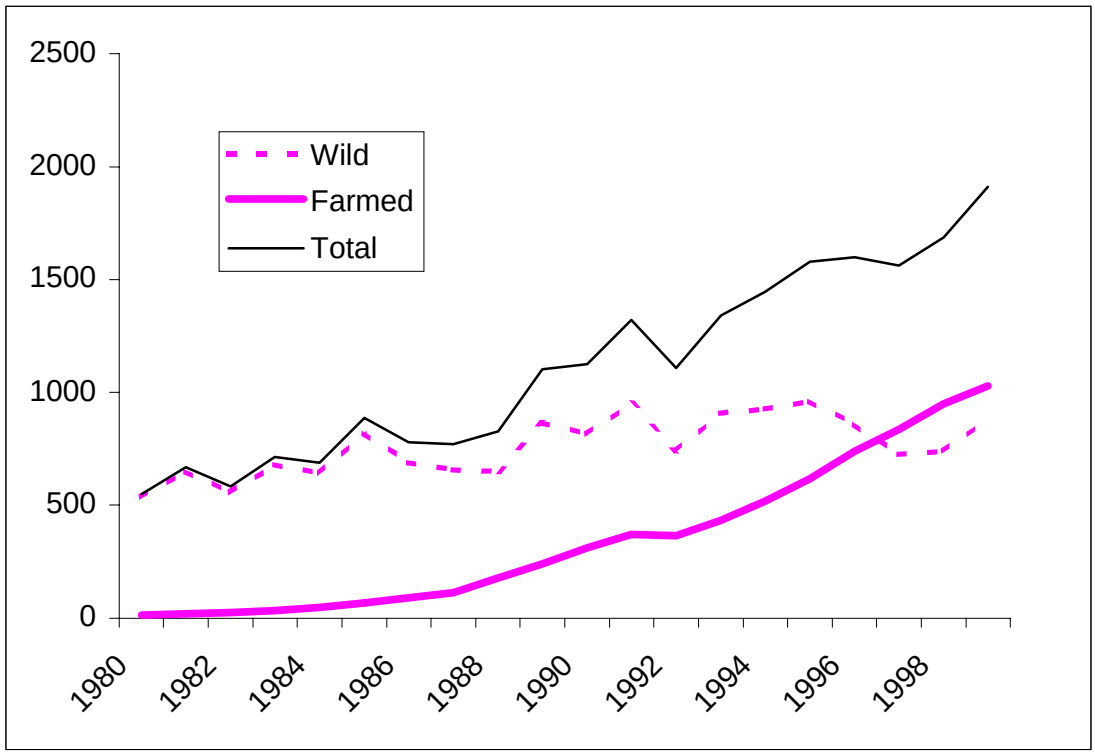
[21] The typical practice is to construct a 90% or 95% confidence interval to ascertain the variability of the series.

7. The salmon value chain in the United Kingdom, Norway, France and Finland

7.1. Introduction

During the last two decades there has been a tremendous growth in the production of intensively farmed fish due to the development of new technologies. Salmon is the most successful of the intensively farmed species when measured by the quantity produced. Salmon aquaculture became commercially interesting in the early 1980s. Since then, the availability of salmon has increased substantially (Figure 7.1). In 1980, the total supply of salmon was about 500,000 tonnes, of which only 13,000 tonnes were farmed. During the 1980s, the landings of wild pacific salmon increased substantially to historically high levels; although these have remained relatively constant at around 800,000 tonnes over the 1990s. However, the most significant change in the salmon market is the huge increase in the supply of farmed fish. From 13,000 tonnes in 1980, farmed production has increased to over one million tonnes in 1999, making the total supply of salmon about 1.9 million tonnes, or almost a quadrupling since 1980. Farmed salmon is produced in large quantities in only a few countries. With their 2000-share in parenthesis, Norway (43 %), Chile (24 %), the UK (13 %) and Canada (9 %) make up about 90% of the total quantity produced.

Figure 7.1: Global supply of salmon in tonnes, 1980-1999



Source: Bill Atkinson's News Reports

Figure 7.2: Global supply of salmon with real Norwegian export price and production cost, 1982-1999

Source: Bill Atkinson's News Report, Norwegian Seafood Exports Council

Total aquaculture production, the real Norwegian export price and production cost are shown in figure 7.2.[22] It is evident that the increase in production has been accompanied by a substantial reduction in prices. In real terms, the price in 1999 was only one third that of 1982. However, production costs have also declined. Hence expansion has been possible because of substantial productivity growth (Bjørndal *et al.*, 1999). Although this suggests that a large part of the growth in salmon aquaculture has been a move down along the demand schedule, there is also evidence that this has been amplified by market growth, partly due to generic advertising programmes (Bjørndal, Salvanes and Andreassen, 1992; Kinnucan and Myrland, 1998).

Until the early 1980s, most of the world's salmon were landed and consumed around the Pacific, with the largest quantity consumed in Japan, followed by the US. In Europe, about 20,000 tonnes of frozen Pacific salmon was imported each year mostly for the smoking industry, and very limited quantities of fresh Atlantic salmon was also available. This changed substantially with the growth of salmon aquaculture, as

[22] The markets for different species (Atlantic, salmon trout, coho, Chinook and sockeye) and product forms (fresh, frozen) of salmon seem to be highly integrated, as will be discussed further in this section of the report. For this reason, the Norwegian export price will be interpreted as the global price of salmon. Note, however, that canned product, typically produced from low value salmon, has not been found to be integrated with the species and product forms referred to above. See Bjørndal (1990) on different species and product forms of salmon.

most of the production took place in Europe (primarily in Norway and Scotland). Low transport costs to Europe saw Europe become the main natural market for expanded production. The main product form consumed in Europe changed from smoked to fresh salmon, as supply of fresh salmon was now readily available within the European market. The European distribution system enabled the delivery of fresh fish in less than three days after removal from the sea. From this base new market segments were created, or taken over, as production increased, and prices and production cost decreased. In less then twenty years, Europe went from being a small salmon consumer to one of the three major salmon markets in the world (together with the Japan and the USA), and at times the largest as measured in value terms.

The increase in salmon production and consumption in Europe, and hence the creation of new market segments as part of a distribution system within Europe, is thought to have changed the organisation of relationships along the seafood value chain. Indeed, the results of industry surveys would tend to indicate that there has been a higher degree of vertical integration between stakeholders at different points along the value chain for salmon in Europe (Guillotreau and Le Grel, 2001). In addition, the survey responses revealed that the race for economies of scale has forced the salmon industry to become more concentrated, especially at the middle stages of the chain (processors and wholesalers).

The two main producing countries in the European Economic Area (Norway and the United Kingdom) had a combined production of 475,000 tonnes of salmon in 1998, at a farm gate value of nearly €1.3 billion. Both of these countries are exporting a large volume of this production, mainly to the French market. The United Kingdom also imports a large quantity of salmon from Norway (15,000 tonnes in 1998), although the share of these imports in total UK supply has declined over time as the UK salmon industry has grown in size. The majority of salmon being exported to France from Norway and the United Kingdom is in whole fresh form for further processing in France. In 1998, Norway exported around 46,000 tonnes of whole fresh salmon to France and the United Kingdom exported around 18,504 tonnes. In comparison, exports of fresh salmon fillets from the United Kingdom in 1998 was 2010 tonnes live weight equivalent and exports of smoked salmon was 925 tonnes live weight equivalent.

France does not produce any salmon domestically and relies completely on imports to satisfy its growing consumer market for salmon. In 1998, France consumed around 104200 tonnes live weight equivalent of salmon. Of this around 50 per cent came from Norway, and 20 per cent from Scotland. The remainder was mainly from North America and Ireland.

The nature of imported salmon products in France has changed from being heavily reliant on frozen product (around 65 per cent of imports in 1982) to being almost totally reliant of fresh product (75 per cent of imports in 1998). Most of this fresh product is imported in whole form. Of the 112,200 tonnes of salmon imported into France in 1998, around 36400 tonnes was processed into smoked salmon by secondary processing units in France. In France, there is a preference for using Norwegian salmon in the smoking process, so no doubt the majority of this salmon was imported from Norway (Guillotreau and Le Grel, 2001). Only a small amount of

salmon is imported already smoked (around 7600 tonnes in 1998). The majority of this product is from the United Kingdom.

At the retail end of the market a similar pattern is emerging with consumption of fresh salmon increasing to 48 per cent of the market in 1998 from 13 per cent in 1982. The majority of this fresh salmon is consumed as fillets (73 per cent in 1998). Consumption of smoked salmon, on the other hand, has fallen from 43 per cent in 1982 to 32 per cent in 1998.

The salmon industry both in the main producing countries of Norway and the United Kingdom, and in the main consuming country, France, is becoming more heavily concentrated at all stages along the chain. At the top of the chain, in Norway and the United Kingdom, a few major producers are responsible for producing the majority of these countries farmed salmon. For example Hydro Seafood, the largest salmon producer in the world in 1998, was responsible for producing around 70,000 tonnes of farmed salmon in both Norway and the United Kingdom in 1998.[23] This company also has its own sales, organisation and processing units in the most important European markets, e.g. France. This case gives a striking example of downstream vertical integration along the salmon chain. In France, it is the opposite. That is, vertical integration is coming upwards from the retailers and processors. For example, the big retail chain, Intermarche, employs some 850 people in its seafood division, which includes those employed in processing plants for salmonids in France.

The examples of vertical integration along the salmon chain given above raise a few theoretical problems as it can represent a discrepancy with the hypotheses of perfect competition. Markets for commodities may entail imperfections that justify in some cases their substitution by a centralised organisation (Williamson, 1987). Also, as companies get larger at different stages of the value chain, there is the possibility of market power. This is especially relevant for the retail sector in France which has become increasingly more concentrated over the past decade. In 1998, the share of supermarkets in total retail sales was 74 per cent and the share of fishmongers was 24 per cent (this excludes sales to the restaurant and catering sector). By comparison, in 1979, these shares were 28 per cent and 66 per cent respectively. A similar phenomena has occurred in the United Kingdom.

In Finland, there is a unique case separate to that which is occurring in France, Norway and the United Kingdom. Salmon trout, rather than salmon, is the dominant species in consumption and is the key species produced in Finland. This fish is similar to salmon in appearance and taste, and on supermarket shelves it is often difficult for the consumer to tell them apart. For this reason imported Norwegian salmon is increasingly being substituted for domestically produced salmon trout in Finland (Guillotreau and Le Grel, 2001).

In 1998, Finland produced around 15,900 tonnes of salmon trout. This production is down from its peak of 19,000 tonnes in 1991. This is due, in part, to competition from Norwegian imports of salmon. This competition is fairly recent, as up until 1993

[23] In 2000 Hydro Seafood was bought by Nutreco, a Dutch company. With exception of its Scottish operation, that Nutreco was forced to sell out again, it was then merged with Marine Havest. At the time Marine Harvest, that was already owned by Nutreco was the second largest salmon producer in the world.

restrictions were placed on imports of salmon into Finland. In 1998, Finland imported some 5,000 tonnes of salmon from Norway. While this represents only a very small proportion of the total Norwegian production (1.4 per cent), it is significant on the Finnish market and it competes with domestically produced salmon trout. Import volumes from Norway are equivalent to around half of domestic salmon trout production.

Around 90 per cent of imported salmon is sold as fresh product in the Finnish market. In that sense Finland differs from many other European countries, where salmon is a common raw material for smoke houses. Meanwhile, salmon trout is increasingly being used by the fish processing industry. The share of processed salmon trout products rose from 30 percent in 1993 to 50 percent in 1999. The type of product produced determines the type of outlet it is sold to further downstream. For instance, 90 per cent of whole fresh gutted fish goes to the retailing sector, whereas 70 per cent of fresh fillets are sold by wholesalers and processors to the catering sector.

The structure of the value chain for salmon and salmon trout in Finland has changed, brought about mainly by the increasing dominance of large supermarket chains in retailing. In the 1970s, the role of fish wholesalers, fishmongers and specialist fish stores was very central. By the 1980s, fish farming had enabled steady supply of fresh fish, which encouraged retail chains to invest in fresh fish counters. Already by the end of 1980s, fresh fish was mainly sold through supermarkets. It was during this time that salmon trout became a common campaign product. Through retail campaigns large quantities of salmon trout are sold weekly with distinctly reduced prices in order to attract people in supermarkets to buy normal priced daily consumer goods. By the 1990s, fresh salmon had replaced salmon trout as the most attractive campaign product.

The retail sector in Finland has become increasingly concentrated, with the market share of two biggest retail chains now at 80 percent of total sales. These retailers trade predominately with a few big multifunctional fish wholesalers, who import, process and sell a wide range of fish products. The combined market share of the six biggest fish wholesale companies in Finland is over 50 percent of the total fish market. The role of traditional fish wholesalers, located around the coastal areas, has changed to undertaking a subcontracting role for the larger multifunctional wholesalers who deal directly with the retail chains.

The production sector for salmon trout has not concentrated as quickly in Finland as in other producer countries. This is due to the restricted environmental license policy, which effectively prevented production growth in fish farms. However some companies have expanded through acquisitions of fish farming places.

The structure of the trade in salmon between Norway, France, Finland and the United Kingdom was illustrated in section 4.3. In the next section of the report this trade will be analysed to determine to what extent prices are related at different stages of the value chain in each of the 4 countries. The analyses will be broken down into two main parts. Firstly the chain for fresh and smoked salmon traded between the United Kingdom and France, and Norway and France will be analysed. Next, the chain for salmon and salmon trout traded within Finland, and between Finland and Norway, will be analysed. In each section an overview of the results of cointegration and

proportionality tests will be presented along with tables of descriptive statistics and margins in both product weights and liveweight equivalents. A more detailed summary of the test statistics from the tests for cointegration, proportionality and exogeneity are presented in Appendix 3.

In order to convert prices to liveweight equivalents for the calculation of margins the cofrepeche comparative study of liveweight equivalents (COFREPECHE 1996) has been used along with industry knowledge in each country. The conversion coefficients used in each country may differ for the same product form. For example, the conversion coefficient for salmon fillets in Finland is 1.47, whereas in the UK it is 1.67. Where a country imports its salmon, the conversion coefficient for the country of origin of the salmon will be used. For a complete list of the conversion coefficients used in this study see Appendix 4.

7.2. Results from analysis of the salmon value chain in the United Kingdom, Norway and France.

In this section, the value chain for fresh and smoked salmon traded between the United Kingdom and France, and Norway and France is analysed. First, the internal markets for salmon in the UK and Norway are analysed. Next, a comparison of the Norwegian and UK chains is made (horizontally) to determine whether the two value chains are related. Finally, the relationship between imported Norwegian salmon in the UK and retail prices for salmon in the UK is analysed.

The second part of the analyses will look at trade in salmon from the UK to France and from Norway to France. First, the market for fresh salmon will be analysed, followed by the market for smoked salmon. Given that in France there seems to be a preference to use Norwegian salmon in the smoking process (Guillotreau and Le Grel, 2001), there may be important differences in the relationships along the chain for smoked salmon as compared to fresh salmon.

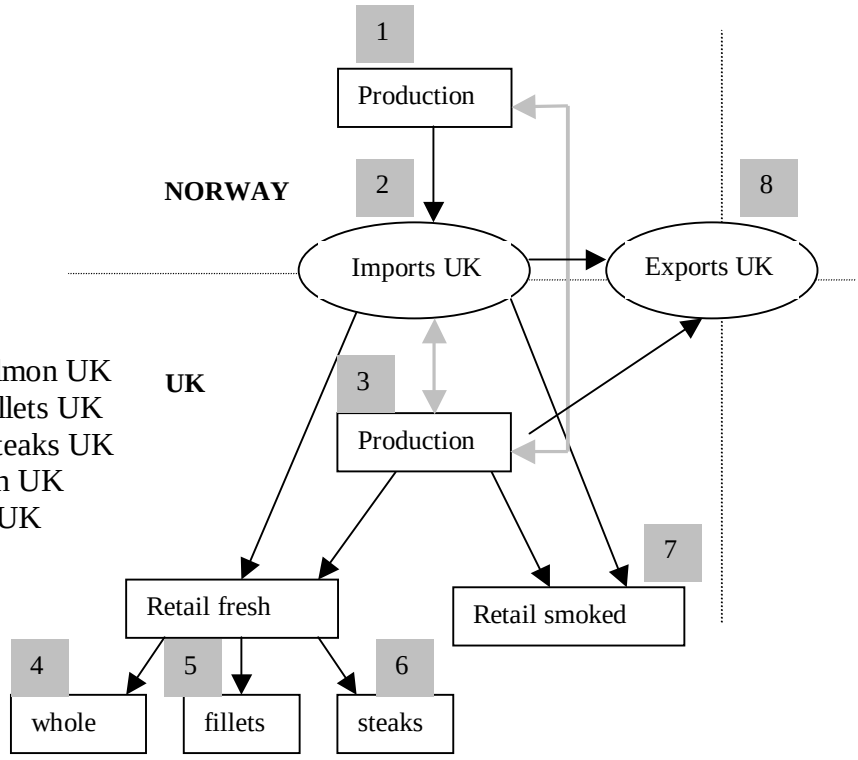
7.2.1. The salmon value chain in the United Kingdom and Norway

In this section we will look at the value chain in the UK, which is the most important market for Scottish salmon producers, and also one of the largest salmon markets in Europe after France. We will also look at the chain that goes from Norway to the UK, as UK processors and consumers also purchase substantial quantities of Norwegian salmon in competition with domestically produced salmon. This is then also a natural place to investigate whether there is any relationship between Norwegian and Scottish producer prices.

The value chain for the United Kingdom and Norway and the price series to be included in the analysis are illustrated in figure 7.3

Figure 7.3: Value chain for salmon in Norway and the United Kingdom

1. Production Norway
2. Imports UK
3. Production UK
4. Retail prices whole fresh salmon UK
5. Retail prices fresh salmon fillets UK
6. Retail prices fresh salmon steaks UK
7. Retail prices smoked salmon UK
8. Export prices fresh salmon UK



Retail prices for smoked salmon in the UK are for smoked salmon fillets and imports of salmon from Norway into the UK are for whole fresh salmon. Export prices from the UK are for whole fresh salmon.

The data were analysed over the time period January 1992 to December 1998. The price series are illustrated in figures 7.4, 7.5 and 7.6.

Figure 7.4: Production, import and retail prices fresh salmon UK

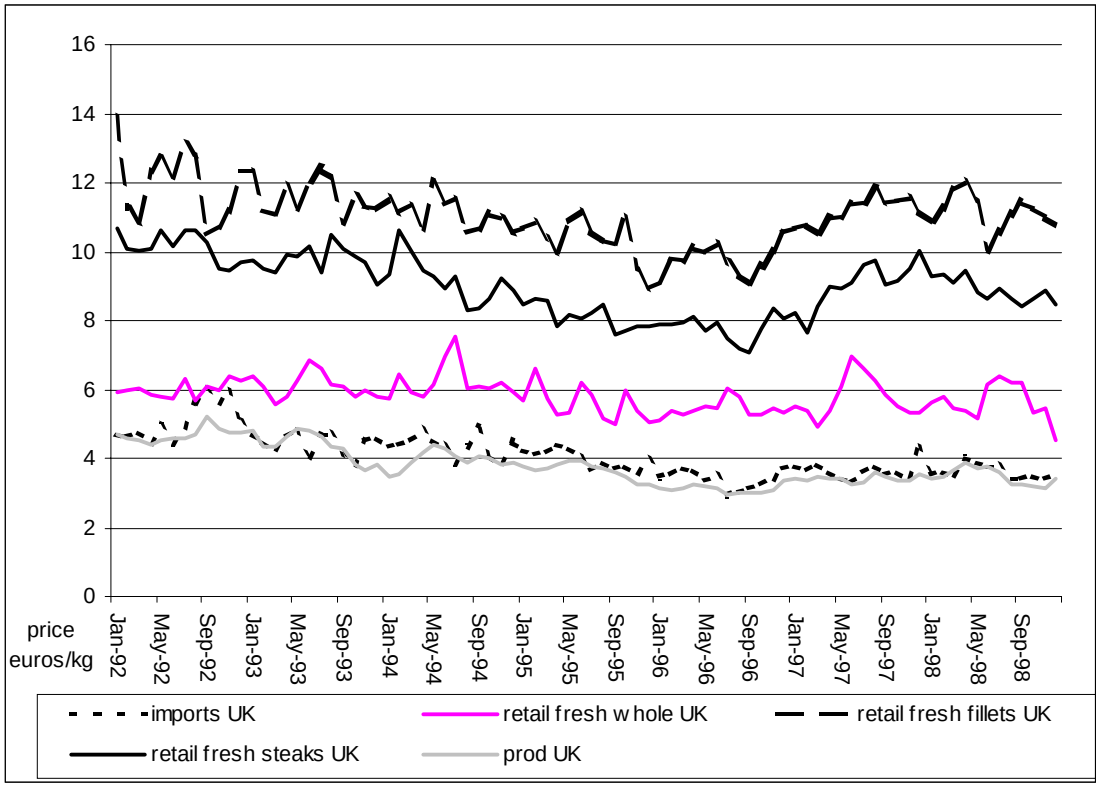


Figure 7.5: Production, import and retail prices smoked salmon UK

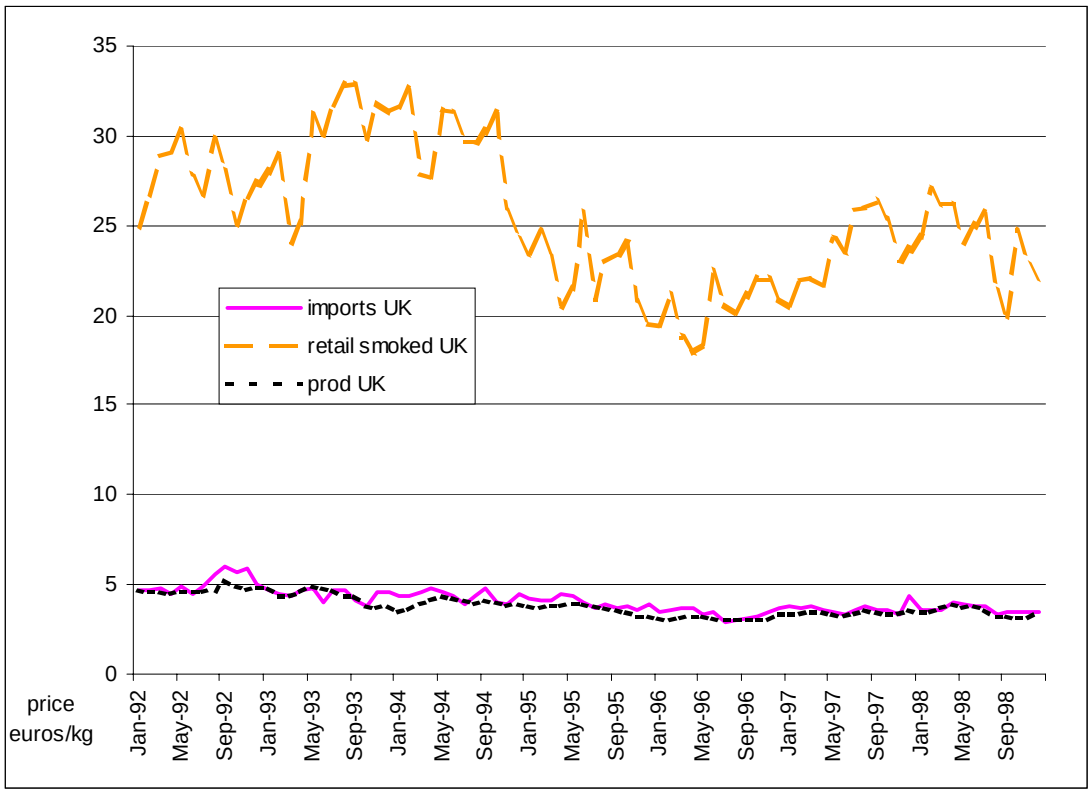
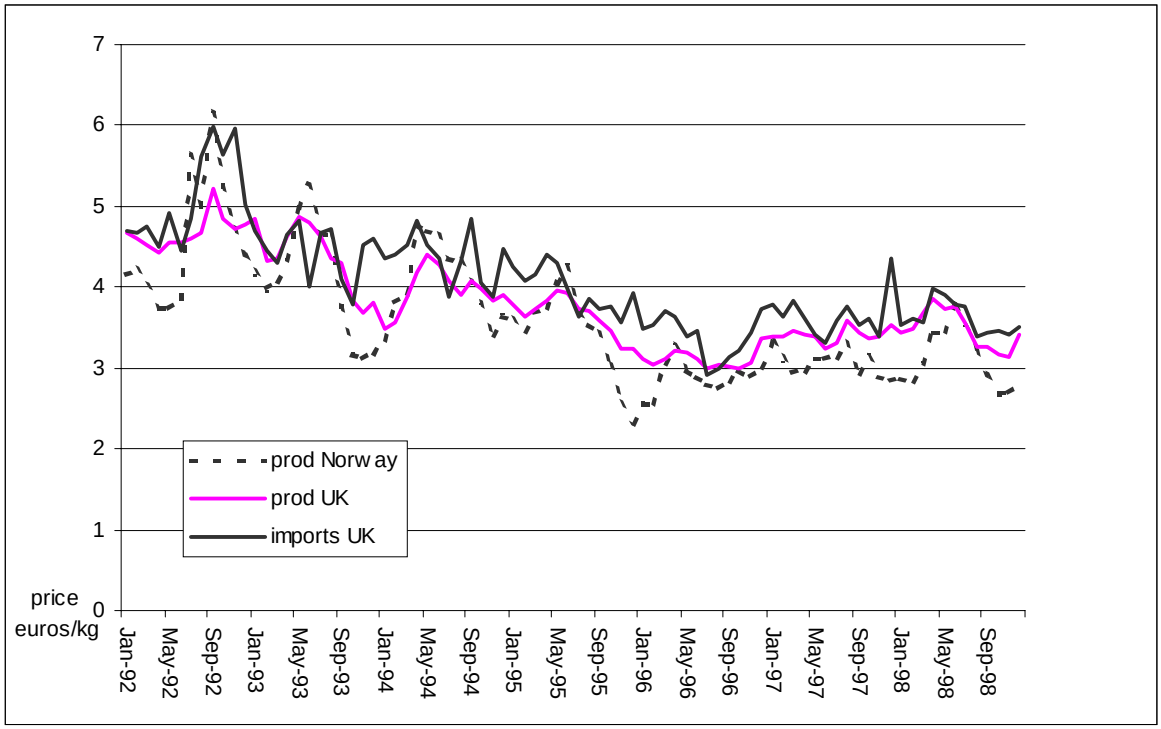


Figure 7.6: Production and imports UK and Norway



A summary of the results from cointegration, proportionality and exogeneity tests is given in table 7.1.

Table 7.1: Results from analysis of the salmon value chain between Norway and the UK

Price 1	Price 2	Cointegration	Proportionality	Exogenous price
Producers UK	Exporters UK	Yes	Yes	Neither
Producers UK	Retailers whole fresh UK	Yes	No	Producers UK
Producers UK	Retailers fillets fresh UK	Yes	No	Neither
Producers UK	Retailers steaks fresh UK	Yes	Yes	Retailers steaks fresh UK
Producers UK	Retailers smoked UK	Yes	Yes	Neither
Producers UK	Producers Nor.	Yes	Yes	Producers UK
Producers Nor	Imports UK	Yes	Yes	Imports UK
Imports UK	Producers UK	Yes	Yes	Neither
Imports UK	Exporters UK	Yes	Yes	Neither
Imports UK	Retailers whole fresh UK	Yes	No	Neither
Imports UK	Retailers fillets fresh UK	Yes	No	Neither
Imports UK	Retailers steaks fresh UK	Yes	Yes	Retailers steaks fresh UK
Imports UK	Retailers smoked sal UK	Yes	Yes	Neither

It is clear from table 7.1 there is a relationship between prices for salmon at production and retail within the UK. In the case of smoked salmon this relationship is proportional. For fresh salmon there is only proportionality in the relationship between production and retail sales of steaks. It is somewhat surprising that we do not find proportionality in the relationship between producers and retailers of whole fresh salmon. However, this may be due to the fact that whole fresh salmon sold at retail is often used as a loss leader.

Producer prices in Norway and the UK are found to be proportional indicating that the Law of One Price holds between these two prices. This implies that these markets are

highly integrated. Although there is obviously no direct interaction between the value chains at this level, there is likely to be interaction at higher levels in the chain. The result is not surprising as Asche and Sebulonsen (1998), Asche, Bremnes and Wessells (1999) and Asche (2001) show that there is a global market for salmon, including salmon from all major producers at the export level. This result is an indication that not only are the markets at higher levels in the value chain highly integrated, but that producers in the two countries receive the same price signals without any distortion along the value chains. This provides evidence that the value chains both in Norway and the UK are highly competitive at the first levels upstream.

Given the link between the producer prices it is not surprising that there is a close relationship between the producer and export, and the producer and import prices, of whole fresh salmon in Norway and the UK, as both these relationships are found to be proportional. Hence, changes in producer prices are being perfectly transmitted to the export level and vice versa. If we consider imports of salmon from Norway to the UK we find a proportional relationship with production in the UK. Furthermore, it is again the case that the relationship between retail sales of smoked salmon is proportional with prices further upstream, and that prices are only proportional in the fresh chain in the case of fresh salmon steaks and prices further upstream. Given the relationships that have already been established for the value chain in the UK, these results also imply that it does not matter whether the salmon comes from Norway or Scotland further up in the value chain for the price determination process.

The results for the exogeneity tests indicate that in the relationship between production and imports with retail sales of salmon in the UK it is generally the case that neither price is found to be exogeneous, giving no clear indication as to the direction of transmission of price information between the different levels. However, producer prices in the UK are exogenous to producer prices in Norway. This result can have at least two different explanations. In several export markets, particularly in France with the *Label Rouge*[24], Scottish producers seem to have been successful in building an image that distinguishes some Scottish salmon from other salmon. There are also indications that Scottish salmon obtains a higher price in some markets than Norwegian salmon, although this relationship is the reverse of what is the case in the UK where Norwegian salmon seems to command a price premium. If Scottish salmon is recognised as a quality leader in a sufficient number of markets, this may give price leadership. Alternatively, it may be explained by poorer ability to store the salmon in Scotland, and therefore that Scottish producers, to some extent, have to sell salmon into the market also under unfavourable market conditions.

Descriptive statistics for each of the price series to be analysed in the UK-Norway value chain are given in table 7.2. In interpreting this table it is important to note that the product form has changed, so part of the margin reflects the conversion from one product form to another (ie. 1 kg of fresh salmon production in the UK results in 0.47 kg of smoked salmon fillets in the UK). The liveweight equivalents of the margins are calculated in table 7.3.

[24] See Mariojouls and Wessells (2001) for the use of the *Label Rouge* in France.

Table 7.2: statistics and margins for the Norway-UK salmon chain (Prices are in Euros/kg).

Price 1	Price 2	Mean	Standard deviation	Coefficient of variation percent	Margin in Euro	Margin in percent	Proportionality
Producers UK		3.80	0.57	15			
	Exporters UK	4.12	0.69	17	0.32	8	Yes
	Importers UK	4.08	0.64	16	0.28	7	Yes
	Retailers fresh whole UK	5.82	0.51	9	2.02	53	No
	Retailers fresh fillets UK	11.02	0.92	8	6.90	189	No
	Retailers fresh steaks UK	8.98	0.91	10	4.90	136	Yes
	Retailers smoked UK	25.36	3.94	16	21.56	567	Yes
Producers Nor		3.61	0.78	22			
	Importers UK	4.08	0.64	16	0.47	13	Yes
	Producers UK	3.80	0.57	15	0.19	5	Yes
Importers UK		4.08	0.64	16			
	Exporters UK	4.12	0.69	17	0.04	1	Yes
	Retailers fresh whole UK	5.82	0.51	9	1.74	43	No
	Retailers fresh fillets UK	11.02	0.92	8	6.44	170	No
	Retailers fresh steaks UK	8.98	0.91	10	4.90	120	Yes
	Retailers smoked UK	25.36	3.94	16	21.28	522	Yes

It is clear from the table 7.2 that a premium is paid for imported Norwegian salmon over UK farmed salmon. However, producer prices for salmon in Norway are lower than producer prices for salmon in the UK. Further downstream, smoked salmon is sold at a mark-up of 522 percent and 567 percent to imports and production respectively (with the mark-up from the import level slightly lower due to the premium paid for Norwegian salmon over locally produced salmon). When prices are measured in liveweight equivalents (table 7.3) the margin becomes significantly lower (231 and 256 respectively). However, this margin is still higher than for any other product form in the value chain, indicating that the highest mark-up is applied to smoked salmon. We would expect this to be the case as the greatest value is added to the product at this stage of the value chain and hence the margins processors apply are higher. In addition, the costs involved in the production of smoked salmon are likely to be higher than for other product forms.

When measured in liveweight equivalents, the margins applied to steaks and fillets of salmon are very close (table 7.3). This would tend to indicate that there is little difference in the value added at these stages of the value chain.

Table 7.3: Descriptive statistics and margins for the Norway-UK salmon chain when prices are measured in liveweight equivalents (Prices are in Euros/kg).

Price 1	Price 2	Mean	Standard deviation	Margin in percent
Producers UK		3.33	0.50	
	Exporters UK	3.61	0.61	8
	Importers UK	3.58	0.56	7
	Retailers fresh whole UK	5.11	0.45	53
	Retailers fresh fillets UK	6.59	0.55	98
	Retailers fresh steaks UK	6.51	0.66	95
	Retailers smoked UK	11.85	1.84	256
Producers Nor		3.17	0.68	
	Importers UK	3.58	0.56	13
	Producers UK	3.33	0.50	5
Importers UK		3.58	0.56	
	Exporters UK	3.61	0.61	1
	Retailers fresh whole UK	5.11	0.45	43
	Retailers fresh fillets UK	6.59	0.55	84
	Retailers fresh steaks UK	6.51	0.66	82
	Retailers smoked UK	11.85	1.84	231

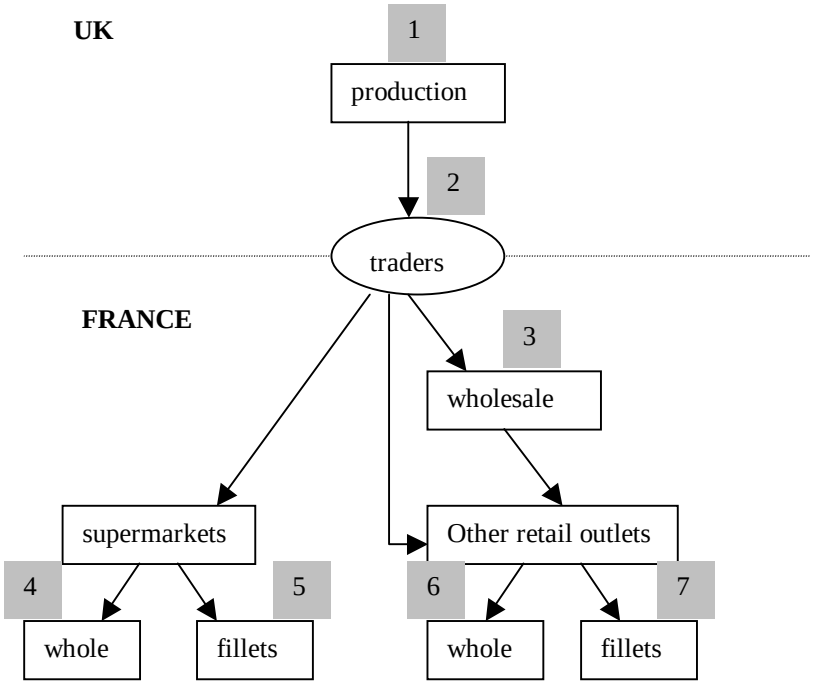
7.2.2. Analysis of the value chain for fresh salmon in the United Kingdom and France.

In this section we look closer at the value chain for fresh salmon from the UK in France. Although Norway has the highest market share here, this is still the largest export market for Scottish salmon. Moreover, France is the largest and most diversified salmon market in Europe.

The value chain for fresh salmon traded between the United Kingdom and France, and the price series to be included in the analysis are illustrated in figure 7.7.

Figure 7.7: Value chain for fresh salmon traded between the United Kingdom and France

1. production UK
2. exports UK
3. wholesale France
4. supermarket sales whole fresh
5. supermarket sales fillets fresh
6. other retail sales whole fresh
7. other retail sales fillets fresh



Exports of salmon from the UK are for whole fresh salmon; wholesale prices for salmon in France are for whole fresh salmon (3-4kg) from Scotland; other retail outlets in France include fishmongers, direct sales etc. In 1998, the share of supermarkets in total retail sales was 74 per cent (this excludes sales to the restaurant and catering sector)..

The value chain for fresh salmon sold through fishmongers and supermarkets in France were analysed separately, because each of these end points receive their salmon through different channels. Supermarkets tend to buy their salmon directly through importers, whereas smaller fishmongers and restaurants tend to source their fish through wholesalers and wholesale markets such as Rungis.

The fresh salmon value chain at the retail level in France into fresh whole salmon and fresh salmon fillets as this made the calculation of live weight equivalent margins

more sensible. The percentage share of fresh whole salmon and fresh filleted salmon in total retail sales over 1990-1998 is shown in figures 7.8 and 7.9. In these figures it is clear that the share of fillets in total retail sales has increased both through supermarkets and fishmongers.

Figure 7.8: Share of fillets and whole in supermarket sales, France.

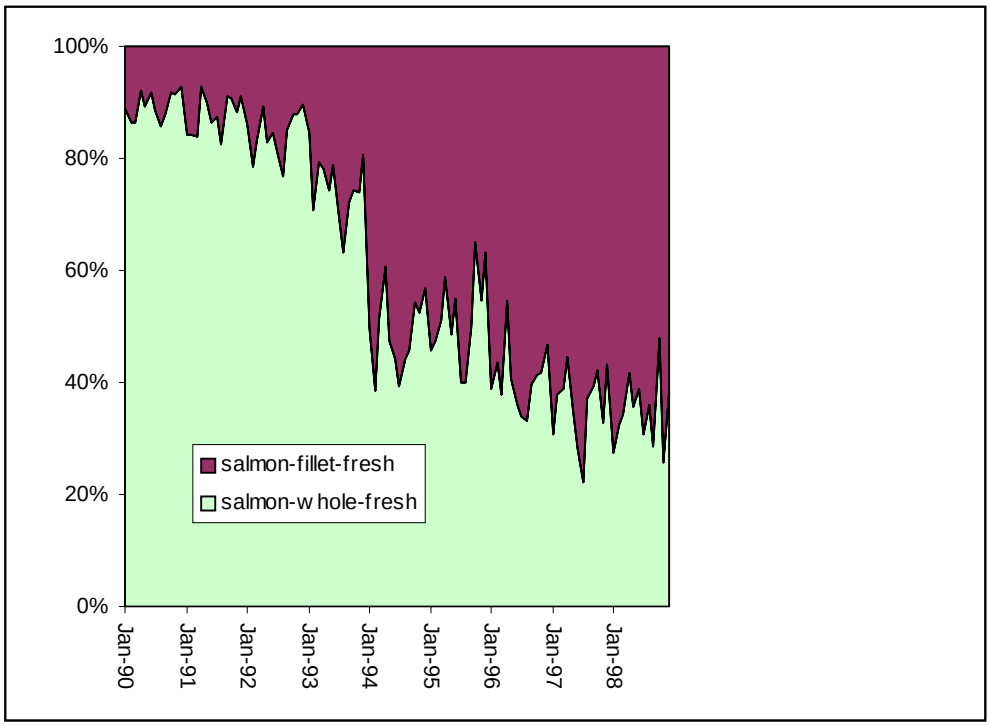
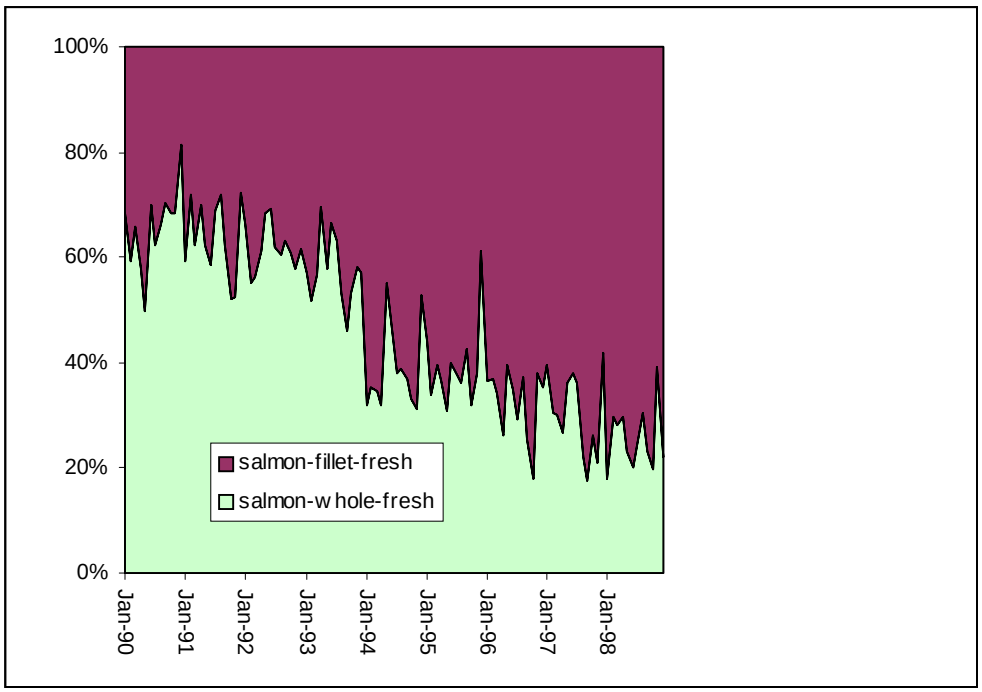


Figure 7.9: Share of fillets and whole in other retail sales, France.



The price series are analysed pair wise between January 1990 and December 1998. They are illustrated in figures 7.10 and 7.11.

Figure 7.10: The UK-French value chain for fresh salmon sold through supermarkets.

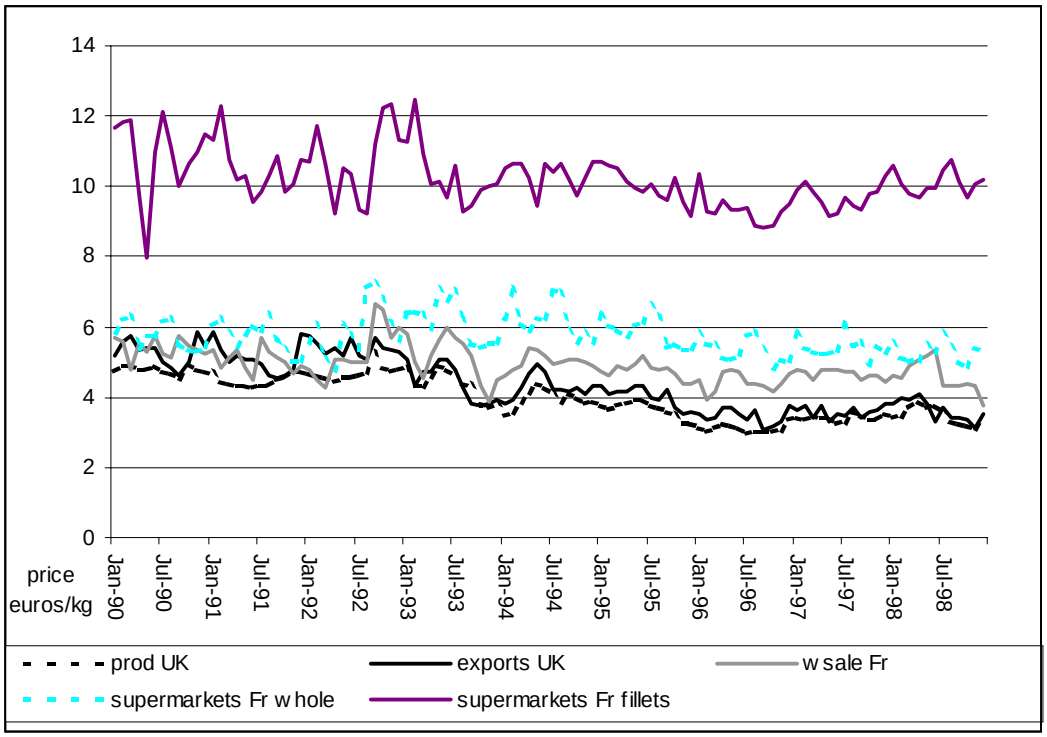
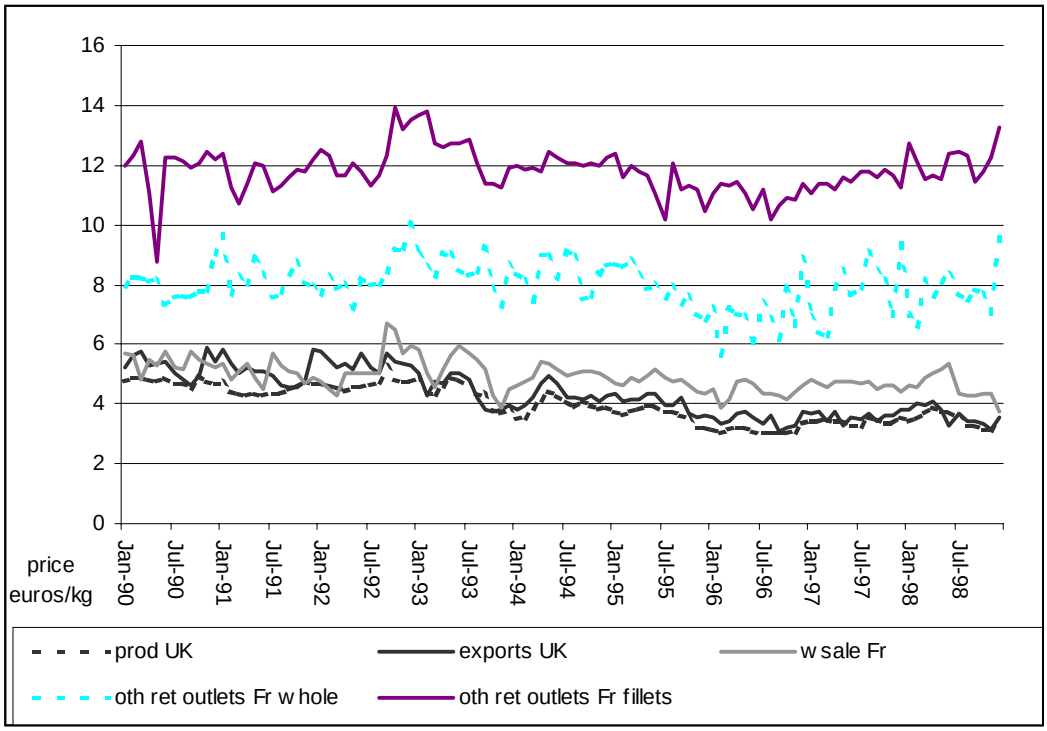


Figure 7.11: The UK-French value chain for fresh salmon sold through other retail outlets.



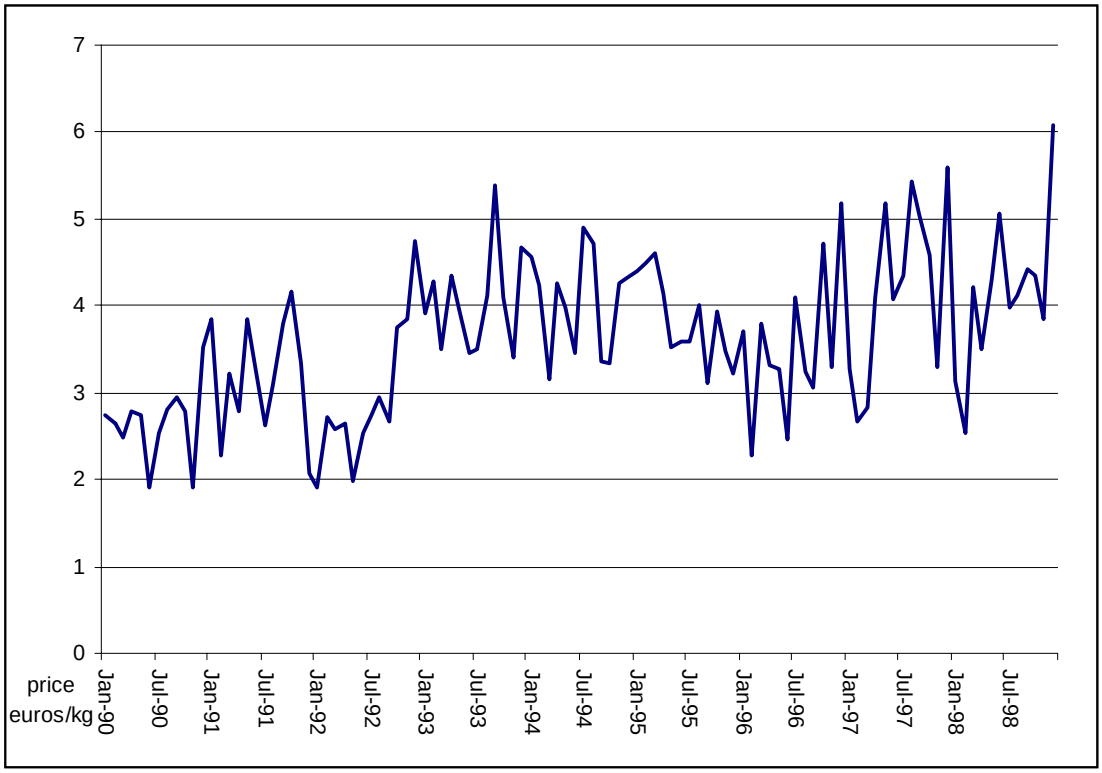
A summary of the results from cointegration, proportionality and exogeneity tests is given in table 7.4.

Table 7.4: Results from analysis of the UK-France fresh salmon value chain

Price 1	Price 2	Cointegration	Proportionality	Trend - perfect price transmission	Exogenous price
Producers UK	Exporters UK	Yes	Yes		Producers UK
Exporters UK	Wholesalers Fra.	Yes	No		Neither
Exporters UK	Smarkets whole fresh Fra	Yes	No		Exporters UK
Exporters UK	Smarkets fillets fresh Fra	Yes	No		Exporters UK
Exporters UK	Other retailers whole fresh Fra	Yes	No	Yes	Exporters UK
Exporters UK	Other retailers fillets fresh Fra	Yes	No		Neither
Wholesalers Fr	Other retailers whole fresh Fra	Yes	Yes		Other retailers whole fresh Fra
Wholesalers Fr	Other retailers fillets fresh Fra	No	_		_

It is clear from table 7.4 that in the relationship between whole salmon sold through other retail outlets in France, and prices further upstream, there is perfect price transmission. Between production and export of fresh salmon there is proportionality indicating that the margin between these two prices is constant over time. Further downstream, in the relationship between export of fresh salmon and whole salmon sold through other retailers in France, there is perfect price transmission with a trend. This would indicate that the margin between these two prices is changing over time, but at a constant rate. We can see from figure 7.12 that the margin between the two prices is getting bigger over the time period under investigation. This would imply that technological change has brought about an increase in the margin over time. A proportional relationship was found between salmon sold through the Rungis wholesale market in France, and whole salmon sold through other retailers in France. It would make sense that we find perfect price transmission in the relationship with whole fresh salmon rather than fresh salmon fillets, as the processes involved in the production of fresh salmon fillets are likely to be more complex than for fresh whole salmon and there is more propensity for input substitution in this process.

Figure 7.12: Margin between export price of fresh salmon in the UK and retail price of whole fresh salmon sold through other retail outlets in France.



The results of the exogeneity tests reveal that, in general, price information is being transmitted down the chain from production to export and export to retail. However, between wholesale and retail sale of the salmon through other retail outlets in France, the price signals become distorted. For instance, in the relationship between wholesale prices and export prices neither price is exogeneous, implying that these prices are being determined at a different point along the chain. In addition, it is retail prices that are determining wholesale prices, rather than the other way around.

Descriptive statistics for the price series analysed in the UK-France value chain are given in table 7.5.

Table 7.5: Descriptive statistics and margins for the UK-France fresh salmon chain (Prices are in Euros/kg).

Price 1	Price 2	Mean	Standard deviation	Coefficient of variation percent	Margin in Euro	Margin in percent	Proportionality
Producers UK		3.99	0.61	15			
	Exporters UK	4.35	0.78	18	0.36	9	Yes
Exporters UK		4.35	0.78	18			
	Wholesalers Fra	4.92	0.51	10	0.57	13	
	Supermarkets whole fresh Fra	5.75	0.57	10	1.4	32	
	Supermarkets fillets fresh Fra	10.21	0.84	8	5.86	135	
	Other retailers whole fresh Fra	7.97	0.82	10	3.62	83	
	Other retailers fillets fresh Fra	11.81	0.76	6	7.46	171	
Wholesalers Fra		4.92	0.78	10			
	Other retailers whole fresh Fra	7.97	0.82	10	3.05	62	Yes
	Other retailers fillets fresh Fra	11.81	0.76	6	6.89	140	

The most striking result from table 7.5 is the difference in variability between retail prices for fresh salmon in France and prices for salmon at levels higher up the chain in the UK, namely at production and export of the salmon. Retail prices for fresh salmon in France are less variable than prices for salmon at production and export in the UK. This may be one of the reasons that relationships between these price series are not found to be proportional. That is, price fluctuations at export are not being perfectly transmitted through to the retail level. It is possible that variability in prices at retail in France is lower because retailers are more than likely trying to keep the price of salmon to consumers relatively constant throughout the year. They do this by absorbing the costs of making losses at certain times of the year when prices they pay for salmon are higher and then offsetting this by making a gain at times when prices they pay for salmon are slightly lower.

In the instance where prices are found to be proportional, it is possible to infer the likely long run mark-up that would apply from the margins calculated in table 7.5. For instance, in the case of production and export of salmon in the UK, the long run mark-

up would be somewhere in the vicinity of 9 per cent. Likewise, the mark-up between wholesale of fresh salmon in France and sale of whole fresh salmon at retail in France is calculated as 62 per cent.

When prices are measured in liveweight equivalents (table 7.6) we can clearly see that the margins applied by other retailers are higher than those applied by supermarkets. This is most evident in the case of whole fresh salmon where the margin applied to product sold through other retail outlets is about 1 ½ times higher than the margin applied to product sold through supermarkets. This may be due to two factors. The first is that product sold through other retail outlets often passes through a wholesaler first before being purchased by the smaller retailers such as fishmongers. As a result there are generally more costs involved in getting it to the consumer. The second is that supermarkets are under pressure to keep the prices they charge to consumers at a low level so they remain competitive. Specialist fish merchants, on the other hand, may be in a position to charge slightly higher prices, or the product they are selling may be of a slightly higher quality than that which is being sold through supermarkets.

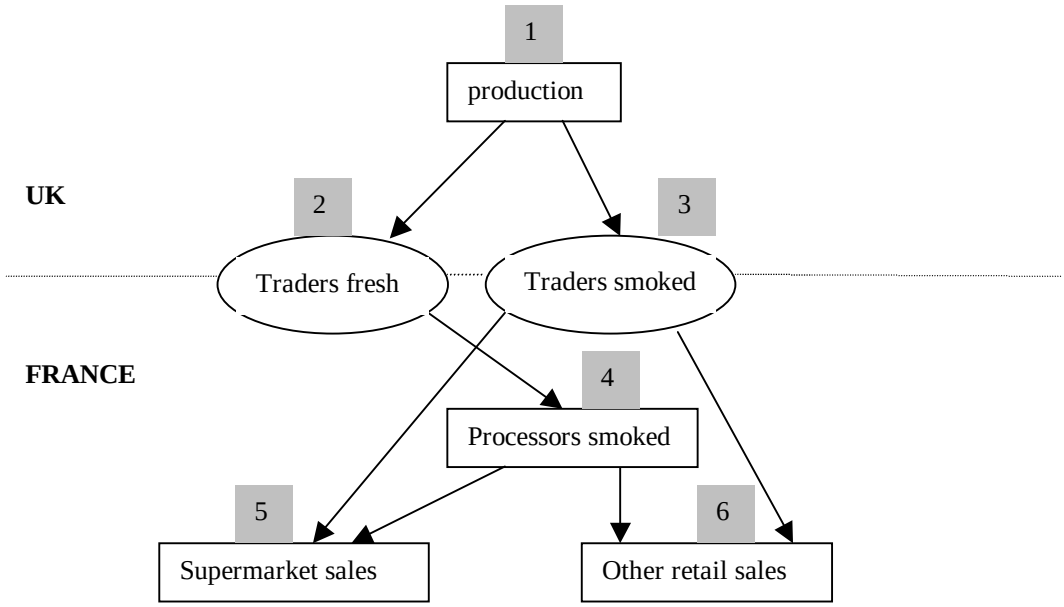
Table 7.6: Descriptive statistics and margins for the UK-France fresh salmon chain when prices are measured in liveweight equivalents (Prices are in Euros/kg).

Price 1	Price 2	Mean	Standard deviation	Margin in percent
Producers UK		3.50	0.56	
	Exporters UK	3.82	0.68	9
Exporters UK		3.82	0.68	
	Wholesalers Fra	4.32	0.45	13
	Supermarkets whole fresh Fra	5.04	0.50	32
	Supermarkets fillets fresh Fra	6.95	0.57	82
	Other retailers whole fresh Fra	6.99	0.72	83
	Other retailers fillets fresh Fra	8.03	0.52	110
Wholesalers Fra		4.32	0.45	
	Other retailers whole fresh Fra	6.99	0.72	62
	Other retailers fillets fresh Fra	8.03	0.52	86

7.2.3. Analysis of the value chain for smoked salmon in the United Kingdom and France

The value chain for smoked salmon traded between the United Kingdom and France, and the price series to be included in the analysis are illustrated in figure 7.13.

Figure 7.13: The value chain for smoked salmon traded between the United Kingdom and France

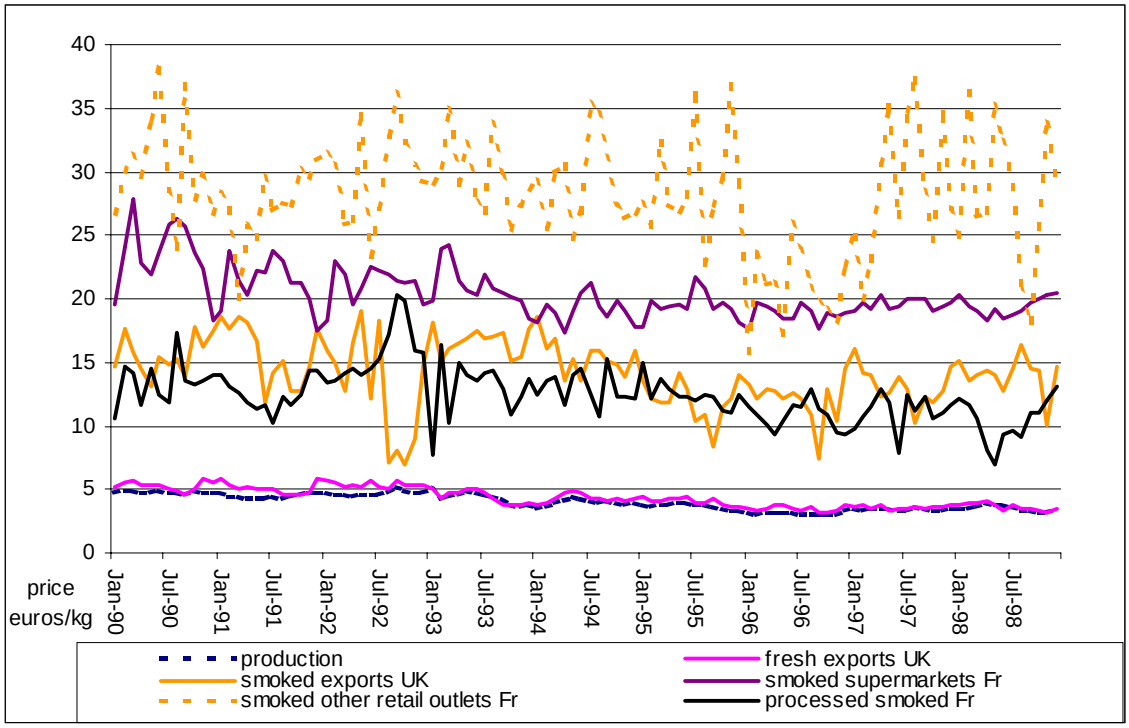


1. production UK
2. export price fresh salmon UK
3. export price smoked salmon UK
4. processor price smoked salmon France
5. supermarket sales smoked salmon France
6. other retail sales smoked salmon France

Prices for exports of smoked salmon in France were used as a proxy for processing prices of smoked salmon in France. Retail prices for smoked salmon in France are for all presentations. Although a small quantity of fresh salmon which is destined for smokehouses is purchased from wholesalers, this amount is only very small and has declined significantly since the late 1980's. In general smokehouses purchase their salmon directly from importers in France. As a result we have omitted the price series for wholesale of fresh salmon from our analysis.

The price series were analysed pair wise between January 1990 and December 1998. They are illustrated in figure 7.14.

Figure 7.14: The French-UK value chain for smoked salmon



A summary of the results from cointegration, proportionality and exogeneity tests are given in table 7.7.

Table 7.7: Results from analysis of the UK-France smoked salmon value chain

Price 1	Price 2	Cointegration	Proportionality	Trend - perfect price transmission	Exogenous price
Producers UK	Exporters smoked UK	Yes	Yes		Producers UK
Exporters smoked UK	Supermarkets Fra	Yes	No		Neither
Exporters smoked UK	Other retailers Fra	Yes	Yes		Other retailers Fr
Exporters fresh UK	Processors smoked Fra	Yes	Yes		Neither
Processors smoked Fra	Supermarkets Fra	No	na		na
Processors smoked Fra	Other retailers Fra	Yes	Yes		Neither

It is clear from table 7.7 that in France price proportionality is found in the chain for smoked salmon sold through other retail outlets, rather than in the chain for smoked salmon sold through supermarkets. This was the same result as was found for fresh salmon exported from the UK to France. However, in the case of the smoked salmon value chain we have a constant margin between export of smoked salmon and retail sale of the salmon, as opposed to a margin which is changing, but at a constant rate, as was found between export and retail sale of whole fresh salmon sold through other retail outlets in France.

It was not possible to find a relationship between processor prices for smoked salmon in France and prices for smoked salmon sold through supermarkets in France. This would tend to indicate that in the smoked salmon chain in France supermarkets exercise a certain degree of market power. However, we cannot conclude this on the basis of statistical tests alone.

Results from the exogeneity tests do not reveal in which direction price information is being transmitted through the value chain as in most cases it is neither price that is exogeneous.

Table 7.8: Descriptive statistics and margins for the UK-France smoked salmon chain (Prices are in Euros/kg).

Price 1	Price 2	Mean	Standard deviation	Coefficient of variation percent	Margin in Euro	Margin in percent	Proportionality
Producers UK		3.99	0.61	15			
	Processors smoked UK	14.15	2.63	19	10.16	255	Yes
Processors smoked UK		14.15	2.63	19			
	Supermarkets Fra	20.37	2.01	10	6.22	44	
	Other retailers Fra	28.12	4.79	17	13.97	99	Yes
Exporters fresh UK		4.35	0.78	18			
	Processors smoked Fra	12.47	2.22	18	8.12	187	Yes
Processors smoked Fra		12.47	2.22	18			
	Other retailers Fra	28.12	4.79	17	15.65	126	Yes

There is a much greater degree of volatility in prices for smoked salmon sold through other retail outlets as opposed to smoked salmon sold through supermarkets in France (table 7.8). This would imply that in the case of the smoked salmon chain it is the supermarkets, and not other retail outlets, that are exhibiting price levelling behaviour by absorbing price fluctuations from points further upstream. In addition, the degree of volatility for prices of smoked salmon sold through other retail outlets in France is much greater than it was for the fresh salmon chain, indicating that these outlets pass on more of the price changes in the case of smoked salmon.

The margins given in table 7.8 allow us to infer some estimates of mark-ups along the value chain in the case where we have found that prices are proportional, and hence the mark-up does not change. In the case of production of fresh salmon and exports of smoked salmon this mark-up is 255 per cent, which is 246 units higher than the mark-up found between production and export of fresh salmon. When prices are converted to liveweight equivalents (table 7.9) this markup is smaller, 89 per cent, and the difference between the fresh and smoked chains at export and production is smaller, at around 80 per cent.

In table 7.9, we can see that, as was the case for fresh salmon, the margin for salmon sold through other retail outlets is higher than that sold through supermarkets. In addition, the margin applied to smoked salmon sold through both of these outlets is much higher between export of fresh salmon and retail sale of smoked salmon than between export of smoked salmon and retail sale of smoked salmon. This would indicate that most of the value added to smoked salmon is added at the earlier stages of the value chain, during processing of the whole salmon into smoked salmon. Another interesting point which can be noted from table 7.8, is that the cost of smoked salmon from the UK is higher than the cost of smoked salmon which is processed in France. This is evidenced by the fact that the margin between export of smoked salmon from the UK and retail sale of smoked salmon in France is lower than the margin between processing of smoked salmon in France and retail sale of smoked salmon. In addition, if we refer to table 7.3, where margins are measured in liveweight equivalents for smoked salmon sold in the UK, we can see that the margin between production and retail sale of smoked salmon in the UK (where retail prices are for salmon sold through all outlets) is generally higher (256 per cent) than between production in the UK and retail sale of smoked salmon in France. This would tend to indicate that more value is added for the smoked salmon chain in the UK than in France.

In general smoked salmon sold on the French market is smoked in France using cheap Norwegian fresh salmon, rather than imported in already smoked. Hence, imports of smoked salmon from the UK makes up only a small part of smoked salmon sold at retail in France.

Table 7.9: Descriptive statistics and margins for the UK-France smoked salmon chain when prices are measured in liveweight equivalents (Prices are in Euros/kg).

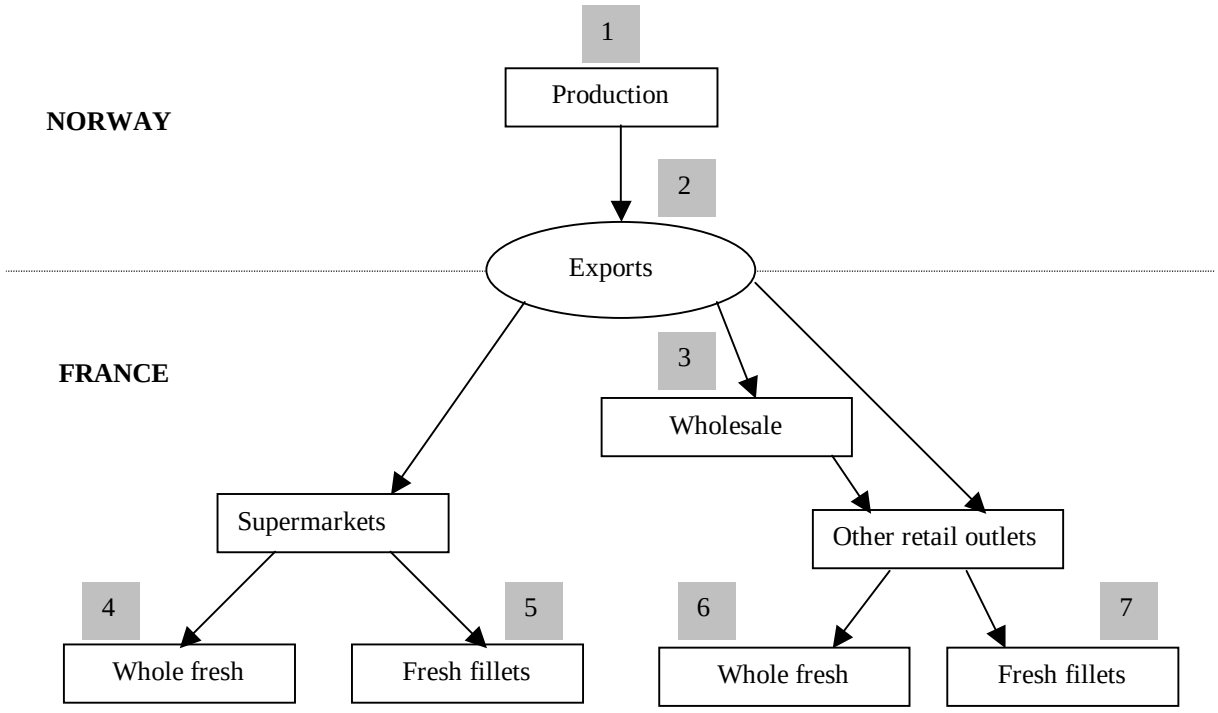
Price 1	Price 2	Mean	Standard deviation	Margin in percent
Producers UK		3.50	0.54	
	Processors smoked UK	6.61	1.23	89
Processors smoked UK		6.61	1.23	
	Supermarkets Fra	9.52	0.94	44
	Other retailers Fra	13.14	2.24	99
Exporters fresh UK		3.82	0.68	
	Processors smoked Fra	5.83	1.04	53
Processors smoked Fra		5.83	1.04	
	Other retailers Fra	13.14	2.24	125

7.2.4. Analysis of the value chain for fresh salmon in Norway and France

In this section we will analyse the value chain from Norway to France for fresh salmon. This is one of the most important chains for Norway as France is the largest salmon market in Europe, and the second largest destination for Norwegian salmon in Europe after Denmark (which re-exports a substantial share of its imports).

The value chain for fresh salmon traded between Norway and France, and the price series to be included in the analysis, are illustrated in figure 7.15.

Figure 7.15: The value chain for fresh salmon traded between Norway and France



1. Production prices Norway
2. Export prices from Norway to France
3. Wholesale price of fresh salmon France
4. Supermarket sales whole fresh salmon France
5. Supermarket sales fresh salmon fillets France
6. Other retail sales whole fresh salmon France
7. Other retail sales fresh salmon fillets France

Exports of salmon from Norway to France are whole fresh salmon. Wholesale salmon is whole fresh salmon (3-4 kg) from Norway

The price series were analysed over the period 1993 to 1999. The price series are illustrated in figures 7.16 and 7.17.

Figure 7.16: The Norway-France value chain for fresh salmon sold through supermarkets.

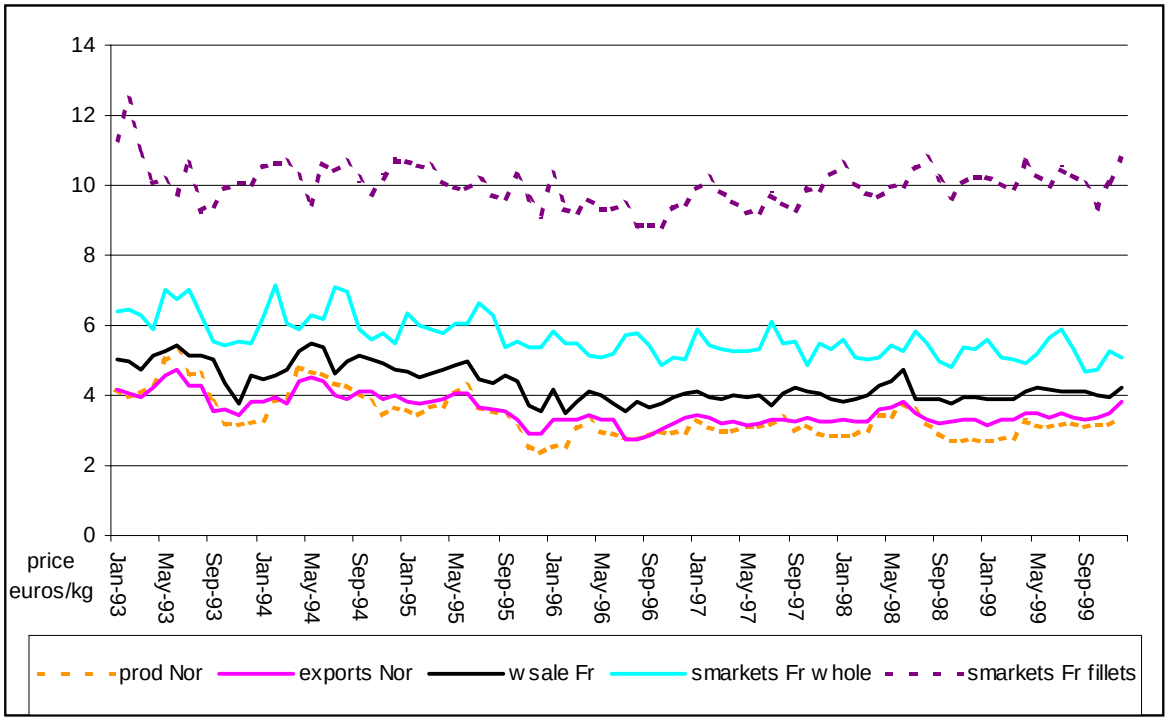
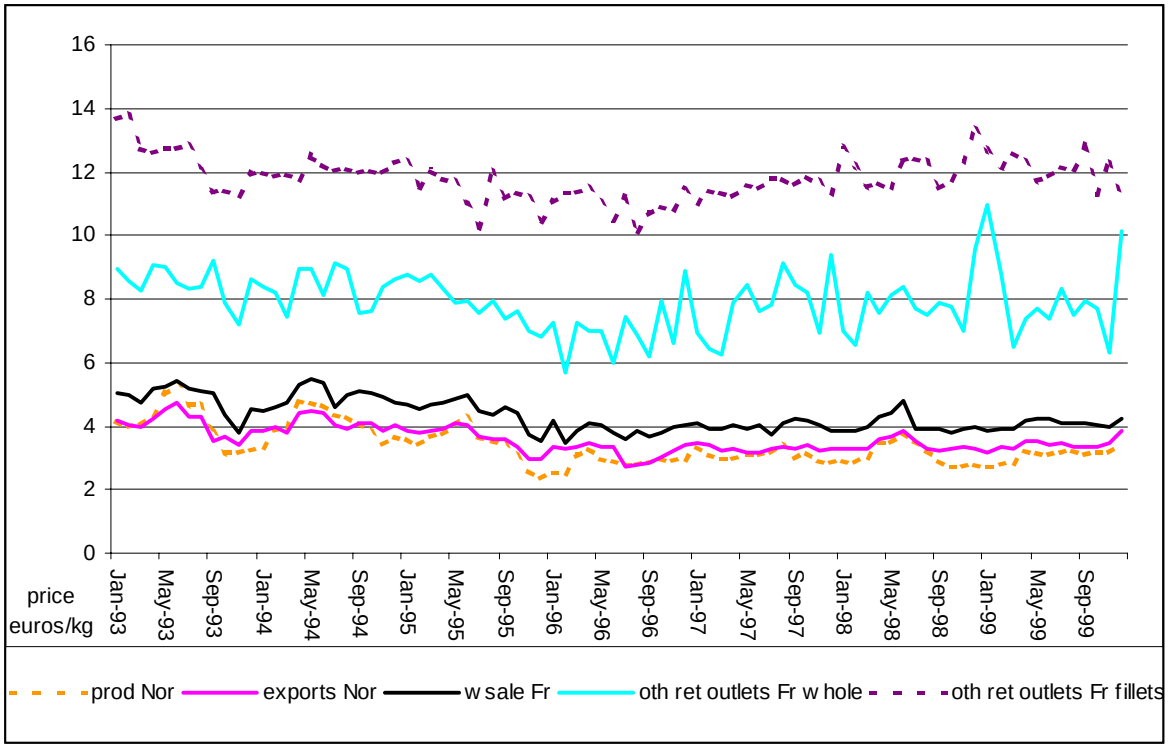


Figure 7.17: The Norway-France value chain for fresh salmon sold through other retail outlets.



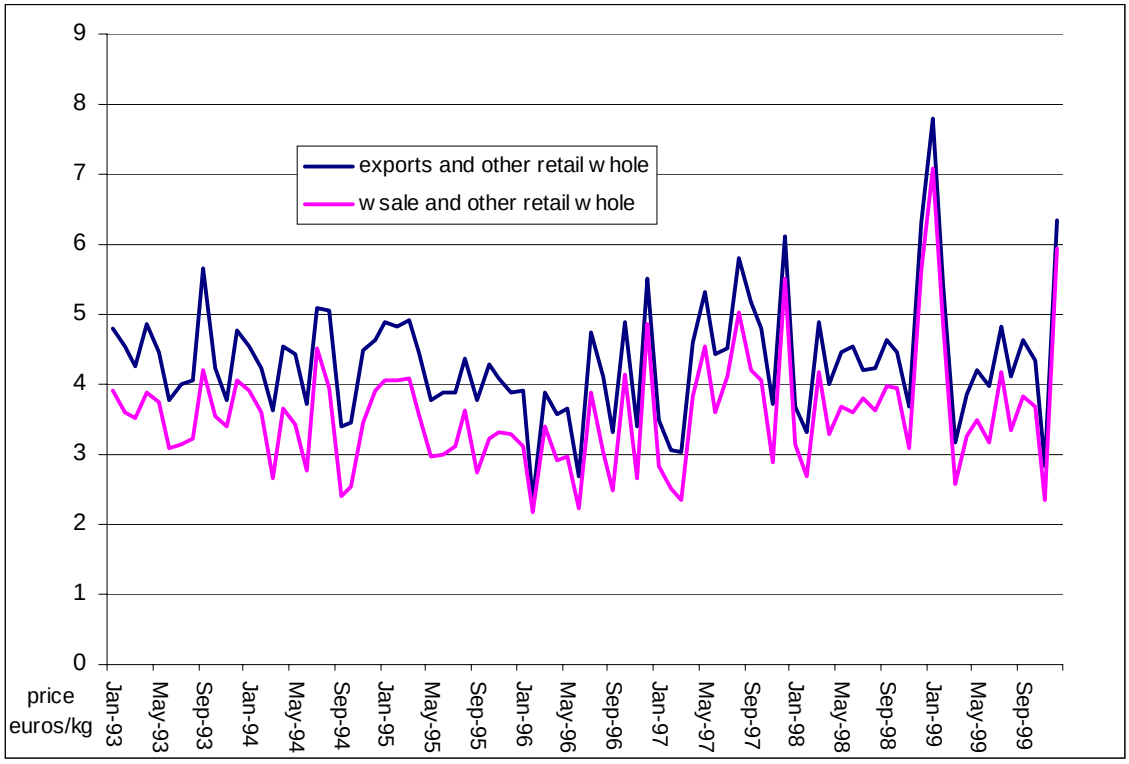
A summary of the results from cointegration, proportionality and exogeneity tests is given in table 7.10.

Table 7.10: Results from analysis of the Norway-France fresh salmon value chain

Price 1	Price 2	Cointegration	Proportionality	Trend - perfect price transmission	Exogenous price
Producers Nor	Exporters Nor	Yes	No		Producers Nor
Exporters Nor	Wholesalers Fra.	Yes	Yes		Wholesalers Fra.
Exporters Nor	Smarkets whole fresh Fra	Yes	Yes		Neither
Exporters Nor	Smarkets fillets fresh Fra	Yes	No		Exporters Nor
Exporters Nor	Oth retailers whole fresh Fra	Yes	No	Yes	Exporters Nor
Exporters Nor	Oth retailers fillets fresh Fra	Yes	No		Exporters Nor
Wholesalers Fra	Oth retailers whole fresh Fra	Yes	No	Yes	Wholesalers Fra
Wholesalers Fra	Oth retailers fillets fresh Fra	Yes	No		Wholesalers Fra

The above results indicate that in the relationship between whole salmon sold through other retail outlets in France and prices further upstream, there is perfect price transmission with a trend. This would indicate that the margin between these prices is changing over time, but at a constant rate. However, it is difficult to see that the margin is changing from figure 7.18. It would appear from the figure that the margin is relatively constant over the long run.

Figure 7.18: Margin between export price of fresh salmon in Norway and wholesale price of fresh salmon in France and retail price of fresh salmon sold through other retail outlets in France.



One interesting result is that there is proportionality in the relationship between exports of fresh salmon from Norway and whole fresh salmon sold through supermarkets in France. This result is surprising mainly because we did not find proportionality between the same points in the UK-France chain. Given that there are proportional relationships further upstream, between Norwegian and Scottish production prices, and also that there is perfect price transmission with a trend between Norwegian and UK export prices, we would not expect to find conflicting results further down the chain.

A potentially problematic result is the conclusion that prices between production and export of salmon in Norway are not proportional. This result is problematic because we would expect prices to be proportional between these two levels, as we found in the fresh salmon chain in the UK. This is also surprising given the link between the Norwegian producer price and the Scottish producer price, and also the links in other places in the chain. Hence, this result could be a statistical artifact. However, it can have at least two other explanations. There have been minimum import prices in place for Norwegian exports to the EU for a number of periods in the 1990s. The extent to which these have been in operation may change the dynamics of the Norwegian exports to France relative to other markets. Alternatively, Norwegian exporters to France may have a different technology from other exporters (for instance a substantial quantity is sold on long term contracts with only a weak link to the spot price) or be able to exercise market power. However, this does not seem very likely given that the export price to France is not higher then to other destinations where Norwegian exporters do not seem to have market power.

The results indicate that price information is being transmitted down the chain. The only possible exception is in the relationship between export and wholesale prices where it is wholesale prices that are determining export prices, rather than the other way around. There is also another instance where the direction of transmission of price information is unclear. That is in the relationship between export prices and retail sale of whole fresh salmon through supermarkets where neither price is exogeneous. This would tend to imply that prices are being determined at some other point along the chain.

The results for the exogeneity tests for the Norway-France value chain are similar to those from analysis of the UK-France value chain. Given that Norway and the UK are the two main producers of salmon, and France is a major consumer, we can conclude that price information is being transmitted down the value chain for fresh salmon.

Table 7.11: Descriptive statistics and margins for the Norway-France fresh salmon chain (Prices are in Euros/kg).

Price 1	Price 2	Mean	Standard deviation	Coefficient of variation percent	Margin in Euro	Margin in percent	Proportionality
Producers Nor		3.39	0.63	18			
	Exporters Nor	3.57	0.43	12	0.18	5	
Exporters Nor		3.57	0.43	12			
	Wholesalers Fra.	4.32	0.51	12	0.75	21	Yes
	Smarkets whole fresh Fra	5.65	0.58	10	2.08	58	Yes
	Smarkets fillets fresh Fra	10.00	0.58	6	6.43	180	
	Oth retailers whole fresh Fra	7.90	0.96	12	4.33	121	
	Oth retailers fillets fresh Fra	11.79	0.70	6	8.22	230	
Wholesalers Fra		4.32	0.51	12			
	Oth retailers whole fresh Fra	7.90	0.78	12	3.58	83	
	Oth retailers fillets fresh Fra	11.79	0.79	6	7.47	173	

The most striking result from table 7.11 is the relatively greater volatility of production prices in Norway when compared with prices further up the chain. It is likely that some of this price volatility is being absorbed by agents further up the chain driven by the need for supermarkets to keep prices to consumers relatively constant.

Of the margins presented in table 7.11, only those for exports of salmon from Norway and wholesale of salmon in France, and exports of salmon from Norway and supermarket sales of whole fresh salmon in France, were found to be constant over the long run. In the case of exports and wholesale the margin was found to be 21 per cent, whereas for exports and supermarket sales it was found to be 58 per cent. These percentages remain unchanged when they are calculated in liveweight equivalents (table 7.12) as there is no change in the product form between one stage and the next.

Table 7.12: Descriptive statistics and margins for the Norway-France fresh salmon chain when prices are measured in liveweight equivalents (Prices are in Euros/kg).

Price 1	Price 2	Mean	Standard deviation	Margin in percent
Producers Nor		2.97	0.55	
	Exporters Nor	3.13	0.38	5
Exporters Nor		3.13	0.38	
	Wholesalers Fra.	3.79	0.45	21
	Smarkets whole fresh Fra	4.96	0.51	58
	Smarkets fillets fresh Fra	6.80	0.39	117
	Oth retailers whole fresh Fra	5.37	0.65	121
	Oth retailers fillets fresh Fra	8.02	0.48	156
Wholesalers Fra		3.79	0.45	
	Oth retailers whole fresh Fra	5.37	0.65	83
	Oth retailers fillets fresh Fra	8.02	0.48	112

The margin calculated for production and exports of salmon in Norway (table 7.12) is lower than that which was calculated for production and exports of salmon in the UK (see table 7.6 section 7.2.2). Given that Norwegian salmon sells at a lower price than

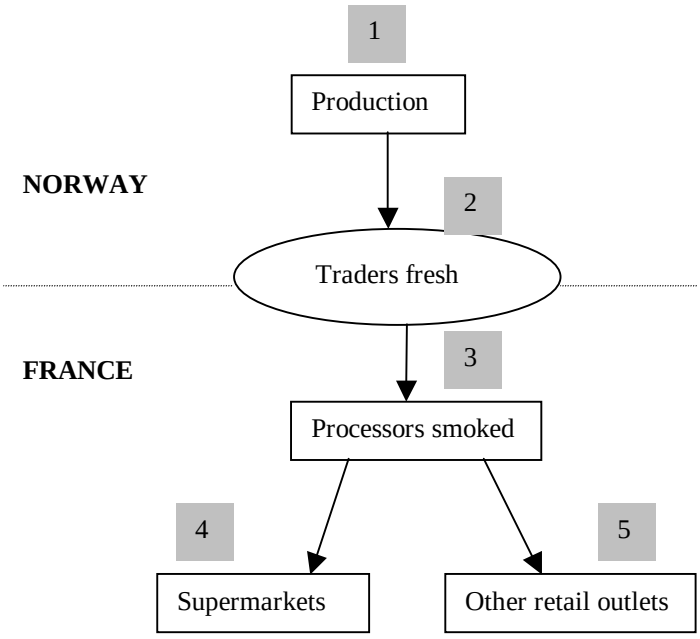
salmon from the UK this would imply that in the absence of any other charges Norwegian salmon would be cheaper to French importers than salmon from the UK.

In comparison to the margins calculated for the value chain between the UK and France (table 7.6 section 7.2.2), the margins between prices along the value chain for salmon sold between Norway and France are relatively larger. It is again the case in the Norway-France chain that the margins calculated for fresh salmon sold through other retail outlets are lower than for salmon sold through supermarkets.

7.2.5. Analysis of the value chain for smoked salmon in Norway and France

The value chain for smoked salmon traded between Norway and France, and the price series to be included in the analysis, are illustrated in figure 7.19.

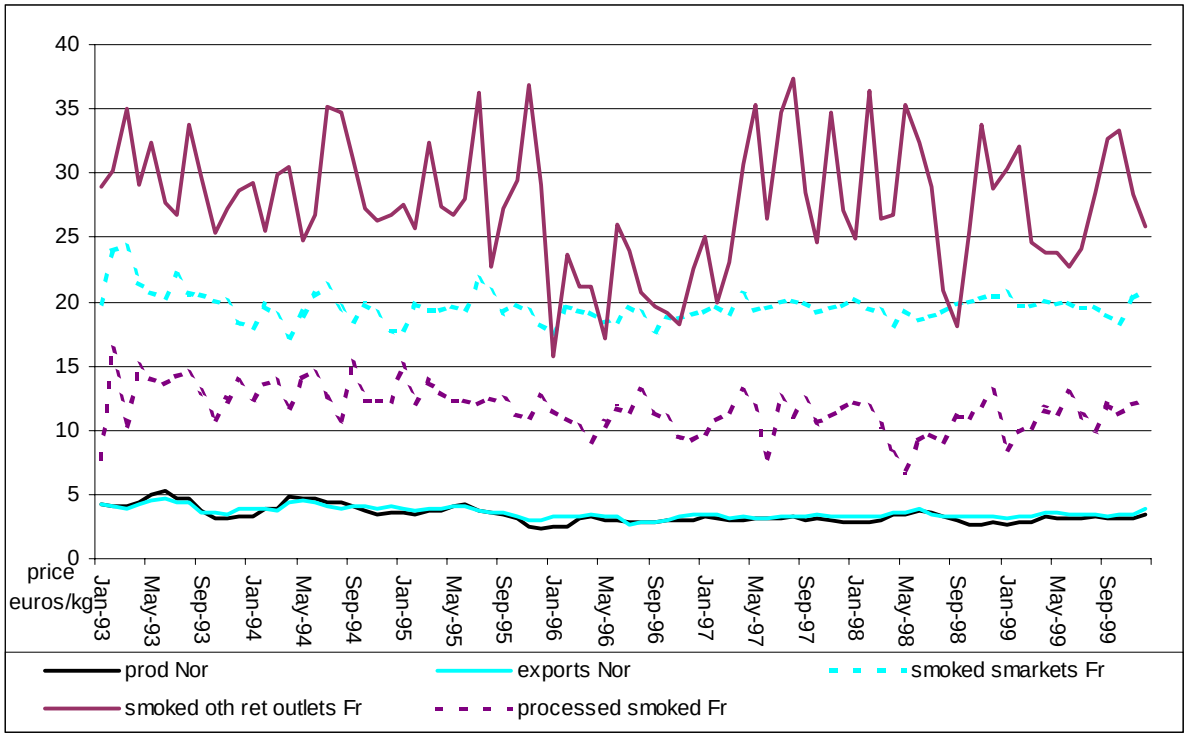
Figure 7.19: The value chain for smoked salmon traded between Norway and France.



1. Production prices Norway
2. Export fresh salmon Norway to France
3. Processors smoked salmon France
4. Supermarket sales smoked salmon France
5. Other retail sales smoked salmon France

Prices for exports smoked salmon in France were used as a proxy for processing prices of smoked salmon in France. The price series illustrated in figure 7.20 were analysed over the time period January 1993 to December 1999.

Figure 7.20: The value chain for smoked salmon in Norway and France.



A summary of the results from cointegration, proportionality and exogeneity tests are given in table 7.13.

Table 7.13: Results from analysis of the Norway-France smoked salmon value chain

Price 1	Price 2	Cointegration	Proportionality	Trend - perfect price transmission	Exogenous price
Producers Nor	Exporters fresh Nor	Yes	No		Both
Exporters fresh Nor	Processors smoked Fra	Yes	Yes		Exporters fresh Nor
Processors smoked Fra	Smoked supermarkets Fra	No	na		na
Processors smoked Fra	Smoked other retail outlets Fra	Yes	Yes		Neither

As was the case for the UK-French market proportionality was found between prices for smoked salmon sold through other retail outlets in France and prices further upstream. It was also the case that prices for smoked salmon sold through supermarkets in France were not cointegrated with prices further upstream. This lends further weight to the argument that supermarkets may be exercising a certain degree of market power. Obviously the result that prices are not proportional between production and export of the salmon is still problematic.

As was the case for the smoked salmon chain in France and the UK, it is difficult to determine in which direction price information is being transmitted through the chain for smoked salmon traded between Norway and France.

In table 7.14, descriptive statistics and margins for the Norway-France smoked salmon chain are presented. Considering only the instances where prices are proportional, it is possible to infer a long run mark-up from the margins calculated in this table. In the case of processor prices for smoked salmon in Norway and prices for smoked salmon sold through other retail outlets in France this mark-up is 136 per cent. For export prices of fresh salmon in Norway and processor prices of smoked salmon in France the mark-up is 227 per cent. When the margin between fresh exports and smoked processor prices is calculated in liveweight equivalents it is significantly less at 74 per cent (table 7.15). The margin calculated between exports of fresh salmon and processor prices for smoked salmon is higher in the Norway-France chain than it was for the UK-France chain (table 7.15). Given that the prices for smoked salmon sold at retail are the same for both analyses, this would imply that more is being paid for exports of fresh salmon from the UK. This may have something to do with the quality perception of salmon by the French consumer. The French consumer is willing to pay more for 'Label Rouge' salmon from Scotland as it is perceived to be of a higher quality. It is likely that smokehouses also pay more for this product to be used in the smoking process. However, in general, French smokers turn to cheaper and more available sources of fresh salmon to be used in the smoking process (i.e. Norwegian salmon).

Table 7.14: Descriptive statistics and margins for the Norway-France smoked salmon chain (Prices are in Euros/kg).

Price 1	Price 2	Mean	Standard deviation	Coefficient of variation percent	Margin in Euro	Margin in percent	Proportionality
Producers Nor		3.39	0.63	18			
	Exporters fresh Nor	3.57	0.43	12	0.18	5	
Exporters fresh Nor		3.57	0.43	12			
	Processors smoked Fra	11.67	1.78	15	8.1	227	Yes
Processors smoked Fra		11.67	1.78	15			
	Smoked other retail outlets Fra	27.58	4.97	18	15.91	136	Yes

Table 7.15: Descriptive statistics and margins for the Norway-France smoked salmon chain when prices are measured in liveweight equivalents (Prices are in Euros/kg).

Price 1	Price 2	Mean	Standard deviation	Margin in percent
Producers Nor		2.97	0.55	
	Exporters fresh Nor	3.13	0.38	5
Exporters fresh Nor		3.13	0.38	
	Processors smoked Fra	5.45	0.83	74
Processors smoked Fra		5.45	0.83	
	Smoked other retail outlets Fra	12.89	2.32	136

7.3. Results from analysis of the salmon value chain in Finland

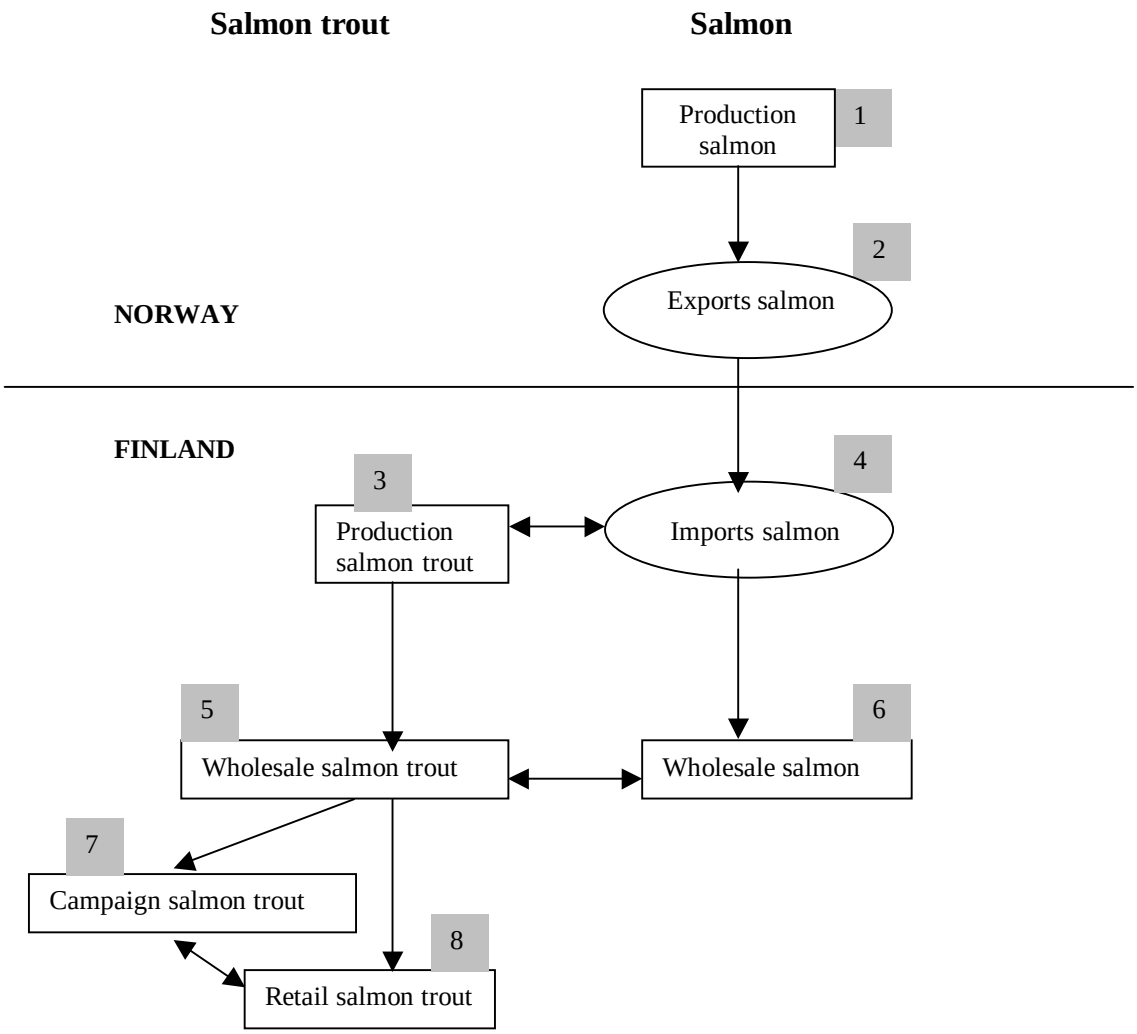
7.3.1. Analysis of the value chain for fresh whole gutted salmon and salmon trout[25] in Finland and Norway

This analysis concentrates on the relationship between prices for salmon traded between Norway and Finland and between fresh gutted salmon trout and salmon sold at farm gate, import, wholesale, retail, and through retail campaigns in Finland. First, the relationship between prices for salmon and salmon trout at the same points along the value chain will be tested to determine if these markets are integrated, and, hence, if the value chains for salmon and salmon trout coincide. Second, the relationship between prices (vertically) at different points along the value chain for salmon and salmon trout will be tested. The salmon trout value chain is tested from producers to retailers, and the salmon value chain from the producers in Norway to wholesalers in Finland.

The value chain for fresh salmon and salmon trout, and the price series to be included in the analysis, are illustrated in figure 7.21.

[25] Salmon trout refers to large size rainbow trout (1-3 kilos marketing size).

Figure 7.21: The value chain for fresh salmon and salmon trout in Finland and Norway.



1. Production prices Norway
2. Export prices salmon Norway
3. Production prices salmon trout
4. Import prices salmon
5. Wholesale prices salmon trout
6. Wholesale prices salmon
7. Retail prices salmon trout
8. Campaign prices salmon trout

Imports of salmon are for whole gutted salmon from Norway. In 1998 Norway represented around 90 per cent of total imports of salmon into Finland. Wholesale prices are for whole gutted salmon and salmon trout. Retail and campaign prices are for whole gutted salmon trout.

Retail campaigns are one off sales campaigns run by the same stores that sell salmon trout at normal prices. They are run in order to clear a large amount of product at a low price. They are usually run about once a week. Campaign prices are very close to

wholesale prices. Cointegration analysis revealed that retail and campaign prices for salmon trout were cointegrated and that there was perfect price transmission with a trend.

The data were analysed over the time period January 1995 to December 1999. The data series for production, retail and campaign prices were available over a longer time period, beginning January 1992. However, as imports of salmon have only been allowed into Finland since 1993, and wholesale prices were only available from 1995, it made more sense to analyse the data over the shorter time period. The price series are illustrated in figures 7.22, 7.23 and 7.24.

Figure 7.22: Prices for salmon and salmon trout

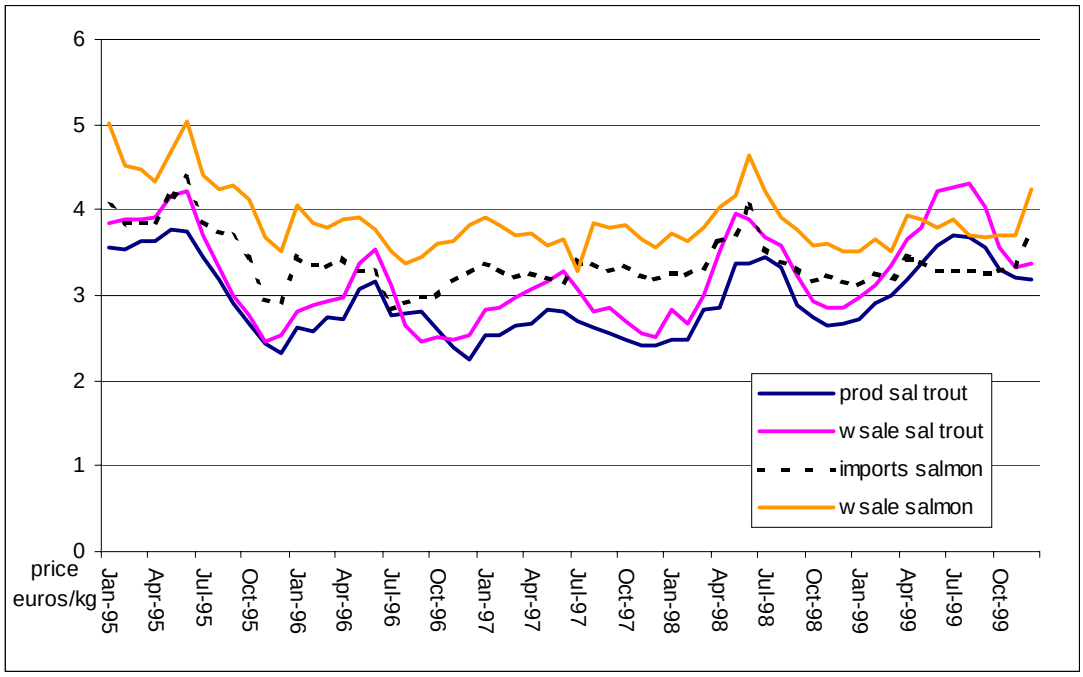
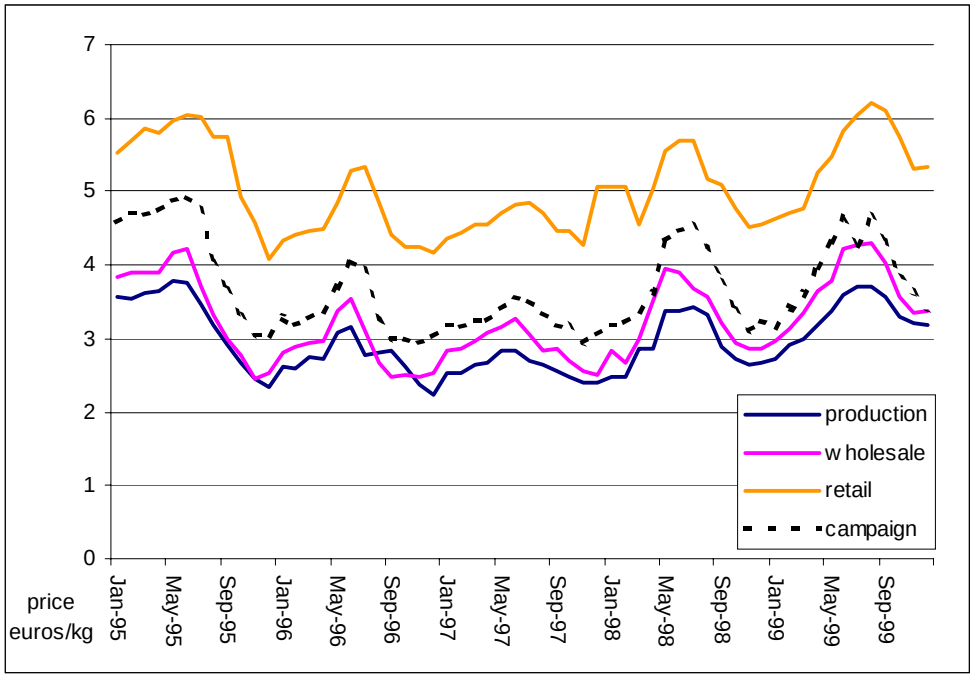


Figure 7.23: Prices for salmon trout in Finland



In figure 7.23 there are instances where wholesale prices for salmon trout fall below production prices. It was over this period (August 1996 to October 1996) that there was disequilibrium in the market for salmon trout in Finland due to the setting of a minimum price for imported salmon in June 1996.

Figure 7.24: Prices for salmon in Norway and Finland

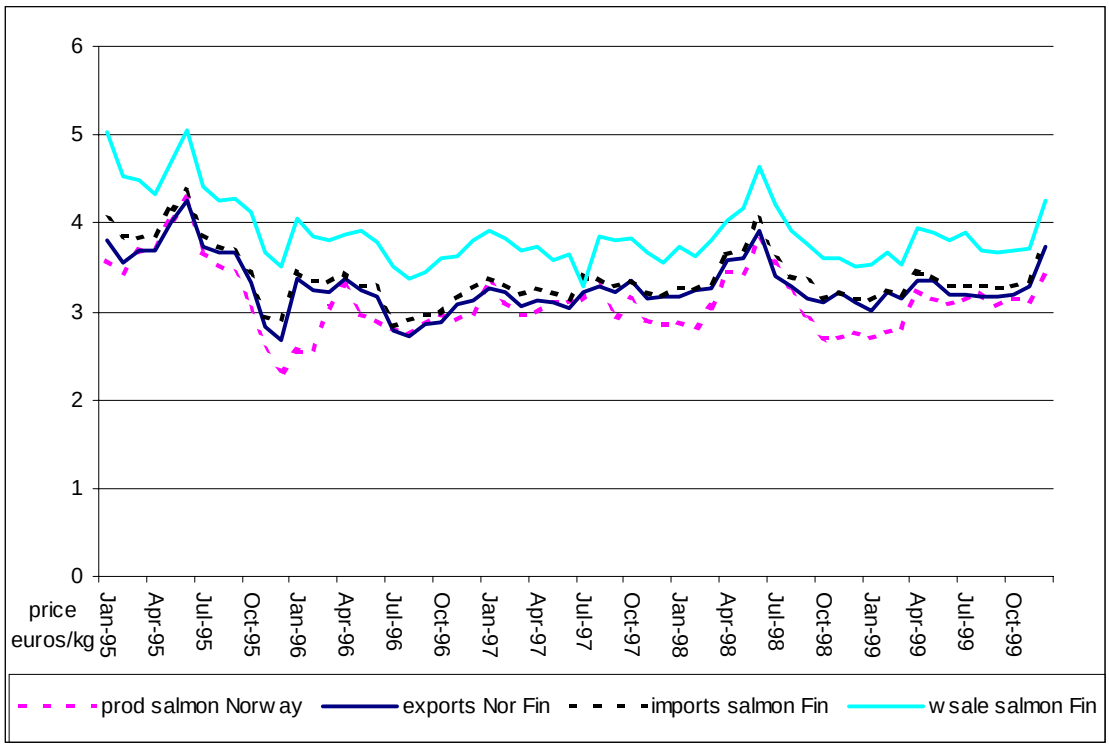


Table 7.16: Results from analysis of the salmon and salmon trout value chain in Finland and Norway

Test	Price 1	Price 2	Cointeg-ration	Proportionality	Trend - perfect price transmission	Exogenous price
Horizontal analysis: Salmon trout/ Salmon	Producers salmon trout	Importers salmon	Yes	No		Neither
	Wholesalers salmon trout	Wholesalers salmon	Yes	No		Neither
Vertical analysis: Salmon trout	Producers	Wholesalers	Yes	Yes		Wholesalers
	Wholesalers	Campaign prices	Yes		Yes	Wholesalers
	Wholesalers	Retailers	Yes	No		Wholesalers
Vertical analysis: Salmon	Producers	Exporters	Yes	Yes		Exporters
	Exporters	Importers	Yes	Yes		Neither
	Importers	Wholesalers	Yes	Yes		Importers

It is clear from table 7.16 that there is a relationship between prices for salmon and salmon trout along the value chain in Finland. This confirms that the two species are in fact substitutes. However, the relationships were not found to be proportional indicating that the two products are not the same. In the case of import prices for salmon, and production prices for salmon trout, it would make sense that we do not find proportionality as a minimum price for imported salmon was set in June 1996.

As we found for salmon markets in other countries, it is at points further up the chain that prices are proportional, ie: between farm gate, export, import and wholesale. This is the case both for salmon and salmon trout. However, in the relationship between wholesale prices for salmon trout, and prices for salmon trout sold through retail campaigns in Finland there is also perfect price transmission with a trend. This is likely to be a result of campaign prices being very close to wholesale prices.

The results of the tests for weak exogeneity in the value chain for salmon trout indicate that wholesalers are in a central position relative to producers and retailers. The wholesale price of salmon trout was found to be exogenous to both the retail and production price. This suggests that wholesale prices are driving prices at other stages in the value chain. We would expect wholesalers to hold a strong postion in the market given that they decide whether to buy domestically produced salmon trout or imported salmon and they also decide what to do with the raw material, i.e. whether to sell it processed or unprocessed.

The results of the tests for weak exogeneity of salmon prices indicate that, on the one hand price information is transmitted from exporters to producers in Norway, and, on the other hand, from importers to wholesalers in Finland. This is further complicated by the fact that in the relationship between import prices in Finland and export prices in Norway neither price is exogeneous.

Descriptive statistics for the salmon and salmon trout value chain are presented in table 7.17.

Table 7.17: Descriptive statistics and margins for the salmon and salmon trout value chain in Finland and Norway (Prices are in Euros/kg).

	Price 1	**Price 2**	**Mean**	**Standard deviation**	**Coefficient of variation percent**	**Margin in Euro**	**Margin in percent**	**Proportionality**
Horizontal analysis: Salmon trout/ Salmon	Producers salmon trout		2.95	0.43	15			
		Importers salmon	3.39	0.31	9	0.44	15	
	Wholesalers salmon trout		3.23	0.54	17			
		Wholesalers salmon	3.89	0.38	10	0.66	20	
Vertical analysis: Salmon trout	Producers		2.95	0.43	15			
		Wholesalers	3.23	0.54	17	0.28	9	Yes
	Wholesalers		3.23	0.54	17			
		Retailers	5.04	0.60	12	1.81	56	
		Campaign	3.68	0.61	16	0.45	14	
Vertical analysis: Salmon	Producer		3.11	0.37	12			
		Exporters	3.29	0.31	9	0.18	6	Yes
	Exporters		3.29	0.31	9			
		Importers	3.39	0.31	9	0.10	3	Yes
	Importers		3.39	0.31	9			
		Wholesalers	3.89	0.38	10	0.50	15	Yes

The wholesale margin of salmon is higher than the wholesale margin of salmon trout (Table 7.17). This may mean that there are higher intermediate costs in the salmon trade or wholesalers get higher premium for salmon than for salmon trout. The former explanation is supported by the fact that many wholesalers buy salmon from an importer or another wholesale company, while salmon trout is bought directly from producers. If the wholesalers get a better profit from salmon, it is a more attractive product to wholesalers.

The series for salmon are clearly less variable over the long run than the series for salmon trout. There are at least two explanations. First, there is considerable seasonal variation in salmon trout production due to the cold winter in Finland. The other reason is that salmon price series are more stable due to the minimum price.

At lower levels of the value chain for salmon and salmon trout there is price proportionality. The corresponding margins in table 7.17 can then be taken as being constant over the long run. In the case of the relationship between wholesale and campaign prices for salmon trout the margin is changing over time but at a constant rate. All other margins are assumed to change over time in response to input substitution by intermediaries along the value chain.

In table 7.18 margins for the Finland salmon and salmon trout chain are calculated in liveweight equivalents. Although average prices along the value chain are lower when calculated in liveweight equivalents, the margins are unchanged because there has been no physical transformation in the product form between production and retail.

Table 7.18: Descriptive statistics and margins for the salmon and salmon trout value chain in Finland and Norway when prices are measured in liveweight equivalents (Prices are in Euros/kg).

	Price 1	**Price 2**	**Mean**	**Standard deviation**	**Margin in percent**
Horizontal analysis: Salmon trout/ Salmon	Producers salmon trout		2.59	0.38	
		Importers salmon	2.97	0.27	15
	Wholesalers salmon trout		2.83	0.47	
		Wholesalers salmon	3.41	0.33	20
Vertical analysis: Salmon trout	Producers		2.59	0.38	
		Wholesalers	2.83	0.47	9
	Wholesalers		2.83	0.47	
		Retailers	4.42	0.53	56
		Campaign	3.23	0.54	14
Vertical analysis: Salmon	Producer		2.73	0.32	
		Exporters	2.89	0.27	6
	Exporters		2.89	0.27	
		Importers	2.97	0.27	3
	Importers		2.97	0.27	
		Wholesalers	3.41	0.33	15

8. Concluding remarks

In this report we have investigated value chains for two of the most important species in the sea food trade in Europe, cod and salmon, using only price data. Economists have always had an interest in relationships between prices, even though the theory in general includes more variables. This is because data on prices is easier to obtain, and often the only available data for the relationships one wishes to study. One form of such relationships is analysis of the value chain. The relationship between two stages in the value chain is well described by the theory of derived demand, where the demand equation is derived from the profit maximization problem of the agent at the highest level in the chain, and the supply equation is derived from the profit maximization problem of the agent at the lower level in the chain (Hicks, 1956; Gardner, 1976). However, the data requirements to estimate such relationships often makes it impossible to estimate them in practice.[26] Therefore, analysis of just prices at different levels is quite common, at least in the value chain for primary products. Gjølberg and Johnsen (1999) and Goodwin and Holt (1999) provide some recent examples for respectively oil products and beef.

In using only price data, the information we can obtain about the value chain is limited. Basically, we can only address three hypotheses with respect to the structure, a) that there is no relationship between prices at different levels in the chain, b) that demand shocks and supply shocks are partly transmitted through the chain, and c) that price transmission is perfect. Only under hypothesis c) can we say something about market structure as with perfect price transmission all cost changes are passed on through the chain. This also implies that the intermediaries production technology can be regarded as having only one variable input (Asche et al, 2002). However, this may not be an unreasonable description in many primary industries (Genovese and Mullin, 199?), and is at least maintained in a number of studies of the value chain including e.g. Cameron-Taubel (1998), Gjølberg and Johnsen (1999) and Goodwing and Holt (1999). In contrast to earlier studies where single equation specifications are used, we utilize a multivariate specification. In doing this we avoid the problem of simultaneity in a market integration context that is also potentially present in models of the value chain. This problem was indicated by Richardson (1978) and elaborated by Goodwin, Grennes and Wohlgenant (1990). Using a multivariate specification is also an advantage if one is interested in price leadership, as different hypotheses are then nested within a multivariate system, while simultaneity makes the results from such tests questionable in single equation approaches.[27] The price series are nonstationarity, and the Johansen test (Johansen, 1988; 1991) is therefore the natural approach.

Two different value chains for cod are studied. The trade in dried-salted cod between Norway and Portugal, and the internal market for imports of frozen cod to the UK. In the first case we are dealing with a product that has been traded for centuries. At all

[26] Also when analyzing only one part of the link, as is common in analysis of import demand, data availability also often create problems, see e.g. Winters (1983) for a powerful critique of the commonly used Armington approach.

[27] This is true both when the data are treated as stationary as CHECK e.g. in Kinnucan and Forker (1987) and when the data are treated as nonstationary but cointegrated as in Gjølberg and Johnsen (1999).

stages many small firms participate in the trade, and processing and transportation technologies are relatively simple and there does not appear to be economies of scale. Hence, it is not surprising that we find that price signals are perfectly transmitted through the value chain, and we can conclude that this chain is highly competitive. It also seems to be the case that frozen cod is the price leader. That is, the Norwegian export price of frozen cod determines the price of dried-salted cod further down the chain in Portugal. This is most likely because Portuguese processors have access to the world market for cod, and with the low cost of processing frozen cod to dried salted cod, the global market price will then determine the retail price. Other product forms will only be bought to the extent that they are competitive with this price, and will then have to follow this price. That the retail price can influence the dried salted and wet salted cod prices is then possible because this fish then already has been committed to this market, but the Portuguese do not have to buy. Norwegian producers of the finished product dried salted cod appear to be relatively competitive on the Portuguese market. However, producers of wet salted cod seem to be losing in the competition with frozen cod as the import share of frozen cod expands at the expense of wet salted cod. Hence, is seems like there is a tendency that the share of the value added is increasing in Portugal. However, since value added is relatively low in this industry, this is not likely to generate greater employment opportunities for processors of dried salted cod in Portugal.

The other value chain that is investigated for cod is for imports of frozen cod to the UK. Although there is an old tradition of cod processing and consumption in the UK, substantial imports of cod is a relatively new feature. The main reason for increased imports is because of low domestic stocks and a need to keep up supplies to the domestic processing industry. Although firms along the chain for cod processing in the UK are, in general, larger than in the Norway-Portugal chain, there are still low margins and many firms. Hence, it is not surprising that we find price transmission to be complete also in this chain. Although both value chains for cod seem highly competitive, there is also increased concentration, and it is likely that this will increase further as the retailers become increasingly concentrated and the supermarket chains further increase their share of total sales. Whether this will give scope for market power, or is just a necessary adjustment to exploit scale economies in new distribution technologies, it is too early to tell.

For salmon we investigated a number of value chains for two product forms; fresh and smoked salmon. The value chains are the chains from the two most important producers, Norway and the UK, to the most important market, France, as well as the domestic chain in the UK, and the trade between Norway and Finland, together with its impact on the domestic Finnish salmon trout industry. As expected, given that several market integration studies have shown that Norwegian and Scottish salmon are close substitutes, the value chains between the two producers are also related. At the first stages price transmission seems to be complete (although the relationship between the Norwegian producer price and export price to France is an exception), and hence the value chains appear to be competitive at the first stages upstream. Moreover, although Norwegian and Scottish salmon do not compete directly at the farm gate level, price transmission is so complete that the Law of One Price also holds at this level.

When one goes further up in the chain the picture is less clear. At some stages there is still complete pass through, though this is most commonly associated with traditional chains where there are still small firms, and for the least processed products (i.e. in the UK it is the case for steaks but not fillets). This also seems to be true for the smoked salmon chain, which may be as expected since the smoking companies are often relatively small, and the fish makes up a very large part of total costs. The tendency against complete pass through is strongest when the retailers are supermarkets. However, this does not seem to be a sign of utilization of market power, as supermarkets tend to have lower prices. This is more likely to be a sign that the hypothesis of Paul (2001) also holds for the seafood value chain in that new processing and distribution technologies requires larger firms to reach the efficient scale. If this is true, one is likely to see a further decline in the number of traditional outlets, and lower value added downstream. However, it is also possible that the price data are distorted as salmon is often used as a loss leader.

In Finland, price signals are completely passed through the chain for salmon trout at the upstream levels, while the signals are distorted between retailers and wholesalers. For salmon we do not have the data to investigate the relationship between wholesale and retail. However, as with the chain for salmon trout, we find perfect price transmission at the upstream levels. Although the value chain for salmon influences the chain for salmon trout at all levels, the Law of One Price does not hold at any level, so salmon and salmon trout are only imperfect substitutes.

The information that we have obtained about the value chains for cod and salmon can then be summed up as follows. In general, the value chains seem to be highly competitive. For cod, price signals are transmitted completely through the chain, and this is also the case upstream for salmon and salmon trout. For salmon this also links the producer prices in Norway and Scotland. It is also the case that for salmon there are often distortions in the chain downstream, although the signals are often completely transmitted from traditional retail outlets. It seems that the largest distortions occur when the retailers are supermarkets. However, as the supermarkets tend to charge a lower price the traditional outlets, this is not a strong sign that the supermarket chains exploit market power. Rather, it is an indication that their distribution costs are lower, and that at least a part of these gains are given to the consumers.

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APPENDICES

Appendix 1: Detailed results from cointegration and proportionality tests for the cod value chain.

Table 1: Johansen cointegration tests for the Norway-Portugal value chain for cod

H0:rank=p	Max test	Trace test	LMa	Proportionalityb	Exogeneityc
Retail and dried salted					
p==0	18.45**	19.62*	1.315 (0.218)	3.424 (0.064)	6.501 (0.011)
p<=1	1.16	1.169	1.210 (0.283		5.661 (0.017)
Retail and salted					
p==0	25.04*	26.05*	0.685 (0.506)	0.794 (0.373)	1.139 (0.286)
p<=1	1.01	1.01	3.062 (0.050)		20.13 (0.000)
Retail and Ex vessel					
p==0	29.99*	31.07*	1.811 (0.053)	2.232 (0.135)	5.846 (0.015)
p<=1	1.07	1.07	1.485 (0.138)		17.42 (0.000)
Retail and Frozen					
p==0	18.54**	19.93*	1.236 (0.266)	1.175 (0.278)	16.10 (0.000)
p<=1	1.39	1.39	0.889 (0.559)		0.045 (0.831)

* indicates significant at a 5% level and ** indicates significant at a 10% level
[a] LM is a test against autocorrelation up to the 12th lag with *p*-value in the parenthesis.
[b] *p*-value in the parenthesis
[c] *p*-value in the parenthesis

Appendix 2: Detailed results from cointegration and proportionality tests for the cod value chain in the UK.

Table 1: Johansen cointegration tests for the frozen cod value chain in the UK

H_0:rank=p	Max test	Trace test	LM[a]	Proportionality[b]	Exogeneity[c]
Wholesale Frozen Fillets and Whole Imports[1]					
p==0	28.82**	40.63**	0.46(0.92)	3.33 (0.067)	6.50 (0.01)
p<=1	1.16	1.169	1.32(0.24)		5.23 (0.02)
Wholesale Frozen fillets and Retail fillet [2]					
p==0	27.03**	36.9**	0.87(0.54)		1.14(0.29)
p<=1	9.06	9.87	1.10(0.39)	3.15(0.076)	2.98 (0.08)

* indicates significant at a 5% level and ** indicates significant at a 10% level
Notes: [a] LM is a test against autocorrelation up to the 12th lag with *p*-value in the parenthesis.
[b] *p*-value in the parenthesis. [c] *p*-value in the parenthesis. **1.** System estimated for 1 lag with a constant term unrestricted and trend term was entered restricted. Dummy variables were added to correct for outliers in September 1997 for Wholesale fillets and October 1996 for whole import. **2.** System estimated for 2 lags with a constant term unrestricted and a trend term unrestricted. Dummy variables were added to correct for outliers in October 1997, January 1998 and November 1999 for Frozen retail prices.

Appendix 3: Detailed results from cointegration and proportionality tests for the salmon value chain.

Table 1: Johansen tests for the Norway-UK salmon chain

Ho: rank = p	Max test	Trace test	Autocorrelation test [a]		Proportionality test [b]	Perfect price transmission trend [c]	Exogeneity test [d]	
			price 1	price 2			price 1	price 2
Producers and exporters UK [1]								
p = 0	27.72**	32.11**	1.64	1.04	0.06		4.29*	5.62*
p ≤ 1	4.39	4.39	(0.16)	(0.40)	(0.80)		(0.04)	(0.02)
Producers and retailers whole fresh UK [2]								
p = 0	27.18**	30.97**	14.91**	2.19	14.91**		0.63	22.13**
p ≤ 1	3.78	3.78	(0.00)	(0.06)	(0.00)		(0.43)	(0.00)
Producers and retailers fillets fresh UK [3]								
p = 0	26.36**	30.02**	1.63	1.96			4.14*	17.33**
p ≤ 1	3.66	3.66	(0.16)	(0.10)			(0.04)	(0.00)
Producers and retailers steaks fresh UK [4]								
p = 0	23.44**	27.61**	1.61	1.06	3.23		12.80**	3.76
p ≤ 1	4.17	4.17	(0.17)	(0.39)	(0.07)		(0.00)	(0.05)
Producers and retailers smoked UK [5]								
p = 0	19.9*	25.73**	1.65	1.48	0.05		6.18*	4.91*
p ≤ 1	5.83	5.83	(0.16)	(0.21)	(0.82)		(0.01)	(0.03)
Producers UK and producers Norway [6]								
p = 0	35.09**	37.89**	0.99	0.77	0.07		2.66	31.58**
p ≤ 1	2.80	2.80	(0.43)	(0.57)	(0.79)		(0.10)	(0.00)
Producers Norway and importers UK [7]								
p = 0	40.26**	43.5**	1.18	1.55	2.19		33.46**	0.21
p ≤ 1	3.25	3.25	(0.33)	(0.19)	(0.14)		(0.00)	(0.64)
Importers and producers UK [8]								
p = 0	32.20**	35.67**	2.16	1.54	0.54		4.88*	10.12**
p ≤ 1	3.47	3.47	(0.07)	(0.19)	(0.46)		(0.03)	(0.00)
Importers UK and exporters UK [9]								
p = 0	23.51**	27.65**	1.87	1.00	0.43		6.69**	6.90**
p ≤ 1	4.15	4.15	(0.11)	(0.42)	(0.51)		(0.01)	(0.01)
Importers and retailers whole fresh UK [10]								
p = 0	31.38**	33.98**	1.29	1.32	12.91**		4.86**	27.81**
p ≤ 1	2.60	2.60	(0.28)	(0.26)	(0.00)		(0.03)	(0.00)

Table 1 continued: Johansen tests for the Norway-UK salmon chain

Ho: rank = p	Max test	Critical value (95%)	Trace test	Critical value (95%)	Proportionality test [a]	Perfect price transmission trend [b]	Exogeneity test [c] price 1	Exogeneity test [c] price 2
Importers and retailers fillets fresh UK [11]								
p = 0	19.68*	26.99**	1.20	1.49	6.22*		6.33*	6.89**
p ≤ 1	7.32	7.32	(0.32)	(0.21)	(0.01)		(0.01)	(0.01)
Importers and retailers steaks fresh UK [12]								
p = 0	22.12**	25.22**	0.99	0.84	1.91		16.37**	0.48
p ≤ 1	3.10	3.10	(0.43)	(0.53)	(0.17)		(0.00)	(0.22)
Importers and retailers smoked UK [13]								
p = 0	19.34*	21.32*	1.02	1.28	0.01		7.54**	4.38*
p ≤ 1	1.98	1.98	(0.41)	(0.28)	(0.93)		(0.01)	(0.04)

** Indicates significant at 1%, * Indicates significant at 5%.

Notes: **a.** The LM test for autocorrelation up to the 12th lag. **a. b. c. d.** *p*-values in parenthesis. **1.** System estimated for 1 lag. A constant was included in the cointegration space in the long run. **2.** System estimated for 1 lag. A constant was included in the cointegration space in the long run. **3.** System estimated for 1 lag. A seasonal component and a constant were included in the cointegration space in the short run. **4.** System estimated for 1 lag. A seasonal component was included in the cointegration space in the short run and a constant was included in the long run. **5.** System estimated for 1 lag. A seasonal component was included in the cointegration space in the short run and a constant was included in the long run. **6.** System estimated for 3 lags. A constant term was included in the cointegration space in the long run. Dummy variables were added to correct for outliers in the residuals for Norwegian producer prices in July 1992, September 1992, April 1994, October 1993 and November 1995, and for UK producer prices in August 1998 and December 1996. **7.** System estimated for 4 lags. A constant is included in the cointegration space in the long run. A dummy variable was added to correct for a outlier in July 1992. **8.** System estimated for 1 lag. A constant was included in the cointegration space in the long run. **9.** System estimated for 2 lags. A constant was included in the cointegration space in the long run. **10.** System estimated for 2 lags. A constant was included in the cointegration space in the long run. **11.** System estimated for 2 lags. A seasonal component was included in the cointegration space in the short run and a constant term was included in the long run. **12.** System estimated for 2 lags A seasonal component was included in the cointegration space in the short run and a constant term was included in the long run. **13.** System estimated for 2 lags. A seasonal component was included in the cointegration space in the short run and a constant term was included in the long run.

Table 2: Johansen tests for the UK-France value chain for fresh salmon

Ho: rank = p	Max test	Trace test	Autocorrelation test [a]		Proportionality test [b]	Perfect price transmission trend [c]	Exogeneity test [d]	
			price 1	price 2			price 1	price 2
Producers and exporters UK [1]								
p = 0	17.94*	26.79**	2.27*	1.49	0.00		0.62	8.38**
p ≤ 1	8.85	8.85	(0.04)	(0.18)	(0.97)		(0.00)	(0.43)
Exporters UK and wholesalers France [2]								
p = 0	26.5**	31.33**	0.66	1.29	18.26**		12.39**	13.76**
p ≤ 1	4.84	4.84	(0.70)	(0.27)	(0.00)		(0.00)	(0.00)
Exporters UK and supermarkets whole fresh France[3]								
p = 0	18.73*	22.84*	1.45	1.79	12.02**		0.10	14.23**
p ≤ 1	4.11	4.11	(0.19)	(0.10)	(0.00)		(0.75)	(0.00)
Exporters UK and supermarkets fillets fresh France[4]								
p = 0	50.97**	62.59**	0.57	1.71		23.00**	0.10	38.82**
p ≤ 1	11.62	11.62	(0.78)	(0.12)		(0.00)	(0.75)	(0.00)
Exporters UK and other retailers whole fresh France[5]								
p = 0	29.08**	37.84**	0.73	0.91		0.40	3.56	15.70**
p ≤ 1	8.75	8.75	(0.65)	(0.51)		(0.53)	(0.06)	(0.00)
Exporters UK and other retailers fillets fresh France[6]								
p = 0	26.93**	35.33**	0.87	0.92	7.41**		6.34*	13.95**
p ≤ 1	8.40	8.40	(0.52)	(0.48)	(0.01)		(0.01)	(0.00)
Wholesalers and other retailers whole fresh France [7]								
p = 0	22.42**	30.55**	0.69	1.15	2.13		9.16**	2.76
p ≤ 1	8.14	8.14	(0.66)	(0.34)	(0.14)		(0.00)	(0.10)

** Indicates significant at 1%, * Indicates significant at 5%

Notes: **a.** The LM test for autocorrelation up to the 12th lag. **a. b. c. d.** *p*-values in parenthesis. **1.** System estimated for 3 lags. A seasonal component was included in the cointegration space unrestricted and a constant term was restricted to enter only in the long run. Autocorrelation was present in the vector for production in the UK at the 5 per cent level of significance. **2.** System estimated for 3 lags. A seasonal component was included in the cointegration space unrestricted and a constant term was restricted to enter only in the long run. Dummy variables were added to correct for outliers in September 1992, December 1998, July 1991, November 1990, February 1996, December 1991 and September 1996. **3.** System was estimated for 3 lags. A constant term was included in the cointegration space over the long run. **4.** System estimated for 2 lags. A seasonal component and a constant term were included in the cointegration space unrestricted and a trend was included restricted. Dummy variables were added to correct for an outlier in May 1990. **5.** System estimated for 2 lags. A constant term and seasonal components were included in the cointegration space in the short run and a trend was included over the long run. **6.** System estimated for 4 lags. A constant term was included in the cointegration space in the long run and seasonal components in the short run. Dummy variables were added to correct for outliers in the series for other retail sales of fresh fillets in May 1990, June 1990, July 1995, December 1995, August 1995, October 1992 and August 1996 and in the series for exports of fresh salmon in the UK in September 1992, November 1990, December 1991 and June 1998. **7.** System estimated for 4 lags. A constant term was included in the cointegration space in the long run. Dummy variables were added to correct for outliers in September 1992 and July 1991.

Table 3: Johansen tests for the UK-France value chain for smoked salmon

Ho: rank = p	Max test	Trace test	Autocorrelation test [a]		Proportionality test [b]	Perfect price transmission trend [c]	Exogeneity test [d]	
			price 1	price 2			price 1	price 2
Producers and exporters smoked UK [1]								
p = 0	43.63*	49.32**	1.23	1.61	3.46		3.03	37.18**
p ≤ 1	5.69	5.69	(0.30)	(0.15)	(0.06)		(0.08)	(0.00)
Exporters smoked UK and supermarkets smoked France [2]								
p = 0	51.23**	59.61**	0.99	1.61	7.58**		29.98**	17.80**
p ≤ 1	8.39	8.39	(0.44)	(0.16)	(0.01)		(0.00)	(0.00)
Exporters smoked UK and other retailers smoked France [3]								
p = 0	41.7*	50.66*	1.27	0.57	0.00		32.72**	0.44
p ≤ 1	8.96	8.96	(0.28)	(0.75)	(0.96)		(0.00)	(0.00)
Exporters fresh UK and exporters smoked France [4]								
p = 0	27.19**	31.6**	0.26	0.92	1.98		9.41**	14.10**
p ≤ 1	4.41	4.41	(0.97)	(0.50)	(0.16)		(0.00)	(0.00)
Exporters smoked France and other retailers smoked France [5]								
p = 0	28.94**	37.95*	1.54	1.58	0.18		9.21**	7.42**
p ≤ 1	9.01	9.01	(0.17)	(0.16)	(0.67)		(0.00)	(0.01)

** Indicates significant at 1%, * Indicates significant at 5%

Notes: **a.** The LM test for autocorrelation up to the 12th lag. **a. b. c. d.** *p*-values in parenthesis. **1.** System estimated for 3 lags. A seasonal component was included in the cointegration space unrestricted and a constant term was restricted to enter only in the long run. A dummy variable was added to correct for an outlier in the series for smoked salmon exports in August 1992. **2.** System estimated for 5 lags. A seasonal component was included in the cointegration space unrestricted and a constant term was restricted to enter only in the long run. Dummy variables were added to correct for outliers in the series for smoked salmon exports in August 1992 and October 1996. **3.** System was estimated for 4 lags. A seasonal component was included in the cointegration space unrestricted and a constant term was restricted to enter only in the long run. Dummy variables were added to correct for outliers in the series for smoked salmon exports in August 1992 and October 1996 and in the series for other retail sales in January 1996. **4.** System estimated for 3 lags. A constant term was included in the cointegration space over the long run. Dummy variables were added to correct for outliers in the series for exports of fresh salmon UK in December 1991 and September 1996 and in the series for exports of smoked salmon France in January 1993 and May 1998. **5.** System estimated for 3 lags. A seasonal component was included in the cointegration space unrestricted and a constant term was restricted to enter only in the long run. Dummy variables were added to correct for outliers in the series for exports of smoked salmon in January 1993, June 1997, May 1998, February 1993 and April 1994 and in the series for other retail sales of smoked salmon in January 1992, January 1994 and October 1994.

Table 4: Johansen tests for the Norway-France fresh salmon value chain

Ho: rank = p	Max test	Trace test	Autocorrelation test [a]		Proportionality test [b]	Perfect price transmission trend [c]	Exogeneity test [d]	
			price 1	price 2			price 1	price 2
Producers and exporters Norway [1]								
p = 0	32.51**	40.03**	1.59	0.85	16.70**		1.80	6.74**
p ≤ 1	7.52	7.52	(0.18)	(0.52)	(0.00)		(0.18)	(0.01)
Exporters Norway and wholesalers France [2]								
p = 0	18.82*	24.71*	0.25	0.82	0.99		6.84**	0.05
p ≤ 1	5.89	5.89	(0.94)	(0.54)	(0.32)		(0.01)	(0.82)
Exporters Norway and supermarkets whole fresh France[3]								
p = 0	22.59**	31.44**	0.44	1.62	2.97		6.43*	7.97**
p ≤ 1	8.85	8.85	(0.82)	(0.17)	(0.08)		(0.01)	(0.00)
Exporters Norway and supermarkets fillets fresh France[4]								
p = 0	63.36**	70.67**	0.28	0.83		29.82**	0.46	50.94**
p ≤ 1	7.31	7.31	(0.92)	(0.54)		(0.00)	(0.50)	(0.00)
Exporters Norway and other retailers whole fresh France[5]								
p = 0	112.1**	118.4**	0.26	0.85		2.56	0.31	97.80**
p ≤ 1	6.34	6.34	(0.93)	(0.52)		(0.11)	(0.58)	(0.00)
Exporters Norway and other retailers fillets fresh France[6]								
p = 0	68.15**	74.64**	0.47	0.86		23.14**	0.86	50.07**
p ≤ 1	6.49	6.49	(0.79)	(0.51)		(0.00)	(0.36)	(0.00)
Wholesalers and other retailers whole fresh France [7]								
p = 0	56.34**	65.92**	2.11	0.44		2.36	0.00	39.42**
p ≤ 1	9.58	9.58	(0.08)	(0.82)		(0.12)	(0.99)	(0.00)
Wholesalers and other retailers filets fresh France [8]								
p = 0	27.56**	37.3**	0.26	3.04*		6.41*	2.81	13.10**
p ≤ 1	9.73	9.73	(0.93)	(0.02)		(0.01)	(0.09)	(0.00)

** Indicates significant at 1%, * Indicates significant at 5%

Notes: **a.** The LM test for autocorrelation up to the 12^{th} lag. **a. b. c. d.** *p*-values in parenthesis. **1.** System estimated for 1 lag. A seasonal component was included in the cointegration space unrestricted and a constant term was restricted to enter only in the long run. Dummy variables were added to correct for outliers April 1994, September 1993, November 1995 and in the series for exports in July 1996 and December 1999. **2.** System estimated for 3 lags. A seasonal component was included in the cointegration space unrestricted and a constant term was restricted to enter only in the long run. Dummy variables were added to correct for outliers in April 1994, September 1993, November 1995 and July 1996. **3.** System was estimated for 4 lags. A seasonal component was included in the cointegration space unrestricted and a constant term was restricted to enter only in the long run. Dummy variables were added to correct for outliers in the series for exports in September 1993, July 1996, November 1995 and in the series for supermarkets whole in May 1993 and September 1997. **4.** System estimated for 2 lags. A seasonal component and a constant term were included in the cointegration space unrestricted and a trend was included restricted. Dummy variables were added to correct for outliers in the series for exports in July 1996 and September 1993 and in the series for supermarkets fillets in August 1993. **5.** System estimated for 1 lag. A constant term and seasonal components were included in the cointegration space in the short run and a trend was included over the long run. Dummy variables were added to correct for outliers in the series for exports in September 1993, July 1996, November 1995, January 1996, April 1994 and in the series for other retail whole in November 1999 and January 1999. **6.** System estimated for 1 lag. A constant term and seasonal components were included in the cointegration space in the short run and a trend was included over the long run. Dummy variables were added to correct for outliers in the series for exports in September 1993, July 1996, November 1995, January 1996, April 1994 and in the series for other retail sales fillets in July 1995, December 1999, December 1998, February 1993 and October 1999. **7.** System estimated for 2 lags. A constant term and seasonal components were included in the cointegration space in the short run and a trend was included over the long run. Dummy variables were added to correct for outliers in the series for wholesale prices in February 1996, December 1993, November 1995, January 1996 and in the series for other retail sales whole in November 1999 and January 1999. **8.** System was estimated for 1 lag. A constant term and seasonal components were included in the cointegration space in the short run and a trend was included over the long run. Autocorrelation was present in the vector for other retail sales of fresh filets in France at the 5 per cent level of significance.

Table 5: Johansen tests for the Norway-France smoked salmon value chain

Ho: rank = p	Max test	Trace test	Autocorrelation test [a]		Proportionality test [b]	Perfect price transmission trend [c]	Exogeneity test [d]	
			price 1	price 2			price 1	price 2
Exporters fresh Norway and processors smoked France [1]								
p = 0	29.67**	38.85**	0.91	0.39	1.15		2.24	17.54**
p ≤ 1	9.18	9.18	(0.48)	(0.85)	(0.28)		(0.13)	(0.00)
Processors smoked France and smoked other retail outlets France [2]								
p = 0	41.54**	48.32**	0.98	1.54	2.77		8.86**	23.04**
p ≤ 1	6.79	6.79	(0.44)	(0.19)	(0.10)		(0.00)	(0.00)

** Indicates significant at 1%, * Indicates significant at 5%

Notes: **a.** The LM test for autocorrelation up to the 12th lag. **a. b. c. d.** *p*-values in parenthesis. **1.** System estimated for 4 lags. Seasonal components were included in the cointegration space in the short run and a constant term was included over the long run. Dummy variables were added to correct for outliers in the series for fresh exports in September 1993 and July 1996 and in the series for procesors smoked in May 1998 and June 1997. **2.** System estimated for 3 lags. A seasonal component was included in the cointegration space unrestricted and a constant term was restricted to enter only in the long run. Dummy variables were added to correct for outliers in the series for processors smoked in June 1997, January 1999, May 1998 and April 1998 and in the series for smoked other retail sales in January 1996.

Table 6: Johansen tests for the value chain for salmon and salmon trout in Norway and Finland

Ho: rank = p	Max test	Trace test	Autocorrelation test [a]		Proportionality test [b]	Perfect price transmission trend [c]	Exogeneity test [d]	
			price 1	price 2			price 1	price 2
Producers salmon trout and importers salmon [1]								
p = 0	25.16**	26.79**	0.83	1.84	21.01**		8.90**	15.43**
p ≤ 1	1.63	1.63	(0.52)	(0.15)	(0.00)		(0.00)	(0.00)
Wholesalers salmon trout and wholesalers salmon [2]								
p = 0	30.42**	31.52**	0.24	1.18			29.10**	4.05*
p ≤ 1	1.10	1.10	(0.91)	(0.34)			(0.00)	(0.04)
Producers and wholesalers salmon trout [3]								
p = 0	23.75**	26.7**	0.54	0.99	0.84		7.84**	1.88
p ≤ 1	2.95	2.95	(0.71)	(0.43)	(0.36)		(0.01)	(0.17)
Wholesalers and retailers salmon trout [4]								
p = 0	49.96**	56.71**	0.29	0.72		4.06*	20.26**	6.24*
p ≤ 1	6.76	6.76	(0.88)	(0.59)		(0.04)	(0.00)	(0.01)
Wholesalers and campaign prices salmon trout [5]								
p = 0	32.48**	41.53**	1.15	2.53		0.75	2.21	17.41**
p ≤ 1	9.05	9.05	(0.35)	(0.05)		(0.39)	(0.14)	(0.00)
Producers and exporters salmon Norway [6]								
p = 0	29.27**	37.63**	2.20	2.16	1.03		4.81*	0.67
p ≤ 1	8.36	8.36	(0.09)	(0.09)	(0.31)		(0.03)	(0.41)
Exporters salmon Norway and importers salmon Finland [7]								
p = 0	24.4**	32.72**	0.71	0.83	0.00		3.82	0.69
p ≤ 1	8.34	8.34	(0.59)	(0.52)	(0.94)		(0.05)	(0.41)
Importers and wholesalers salmon [8]								
p = 0	43.38**	44.8**	2.05	2.39	0.43		0.02	16.12**
p ≤ 1	1.41	1.41	(0.11)	(0.07)	(0.51)		(0.90)	(0.00)

** Indicates significant at 1%, * Indicates significant at 5%

Notes: **a.** The LM test for autocorrelation up to the 12^{th} lag. **a. b. c. d.** *p*-values in parenthesis. **1.** System estimated for 2 lags. A seasonal component was included in the cointegration space unrestricted and a constant term was restricted to enter only in the long run. Dummy variables were added to correct for outliers in January 1996 and in production prices for salmon trout in May 1998, September 1998 and May 1996 and in import prices for salmon in July 1996, November 1995, December 1999 and June 1998. **2.** System estimated for 1 lag. A constant term and seasonal components were included in the cointegration space in the short run. Dummy variables were added to correct for outliers in the series for wholesale prices of salmon trout in August 1996 and April 1998 and in the series for wholesale prices of salmon in June 1995, January 1996, December 1999, July 1997 and June 1998. **3.** System estimated for 3 lags. A seasonal component was included in the cointegration space unrestricted and a constant term was restricted to enter only in the long run. **4.** System was estimated for 4 lags. A constant term was included in the cointegration space in the short run and a trend term was restricted only to enter the cointegration space in the long run. Dummy variables were added to correct for outliers in June 1999, December 1996, January 1998, November 1995, December 1997, September 1995 and May 1998. **5.** System estimated for 1 lag. A constant term was included in the cointegration space in the short run and a trend term was restricted only to enter the cointegration space in the long run. Dummy variables were added to correct for outliers in August 1996, December 1996, November 1995, May 1998, June 1999, April 1998 and December 1995 **6.** System estimated for 2 lags. A constant term was included in the cointegration space in the long run and seasonal components in the short run. Dummy variables were added to correct for outliers in the series for production prices in May 1995 and in the series for export prices in January 1996, November 1995 and December 1999. **7.** System estimated for 1 lag. A constant term was included in the cointegration space in the long run and seasonal components in the short run. **8.** System estimated for 2 lags. A constant term was included in the cointegration space in the long run and seasonal components in the short run. Dummy variables were added to correct for outliers in December 1999 and January 1996, in the series for import prices in November 1995, July 1997 and July 1996 and in the series for wholesale prices in July 1999.

Appendix 4: Liveweight equivalent conversion factors

Table 1: Conversion factors used in calculating liveweight equivalents for cod in Norway and Portugal

State	Presentation	Converstion factor
Dried salted	Whole gutted	4.3
Wet salted	Whole gutted	3
Frozen	Whole Gutted	1.6
Frozen	Fillet	3

Source: Cofrepeche 1996.

Table 2: Conversion factors used in calculating liveweight equivalents for cod in the United Kingdom

State	Presentation	Converstion factor
Frozen	Whole Gutted	1.52
Frozen	Fillet	2.60

Source: Cofrepeche 1996.

Table 3: Conversion factors used in calculating liveweight equivalents for salmon in France, Norway, Finland and the UK.

Country	State	Presentation	Conversion factor
United Kingdom [1]	Fresh	whole gutted	1.14 (1.09) [a]
	Fresh	fillets	1.67
	Fresh	steaks	1.38
	Smoked	fillets	2.14
France [2]	Fresh	fillets	1.47
	Smoked	all presentations	2.14
Norway [3]	Fresh	whole gutted	1.14 (1.2) [a]
Finland [3]	Fresh salmon trout	whole gutted	1.14 (1.11) [a]
	Fresh salmon trout	fillets	1.47
	Fresh salmon	fillets	1.47

Sources: 1. Personnel communication Alan Greene, M&J Seafoods, Fleetwood, UK, September 2000. 2. Cofrepeche 1996, Personnel communication Alan Greene, M&J Seafoods, Fleetwood, UK, September 2000. 3. Cofrepeche 1996.

Notes: a. For fresh gutted salmon an average of the liveweight equivalent conversion factors in the two main salmon producing countries (UK and Norway) was calculated. In parenthesis the actual conversion factor for each country is given. It is expected that there would not be a great deal of difference in the relative weight of a gutted salmon across the two countries so this was considered to be the best approach. The same conversion factor was also applied to fresh gutted salmon trout in Finland for consistency.