

Competitiveness of salmon and salmon trout markets along the value chain in Finland

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Abstract.

The fish market in Finland has changed dramatically since the removal of trade barriers to the importation of fresh salmon in 1993. Imported salmon has rapidly captured markets from domestically produced salmon trout. Another clear trend has been increased concentration at the wholesale and retail level, which in turn has increased the possibility to exploit market power for those firms with key locations along the value chain. In this paper we use price data and apply co-integration techniques to investigate the relationship between salmon and salmon trout at different points along the fish marketing chain. It can be concluded that salmon and salmon trout are substitutes in the fresh fish market and that the value chains for both fish species are competitive from the producer to wholesaler level. In addition, the role of wholesalers is central in the salmon trout value chain.

Keywords: Cointegration, Salmon Trout, Salmon, Market power, Value Chains

1. Introduction

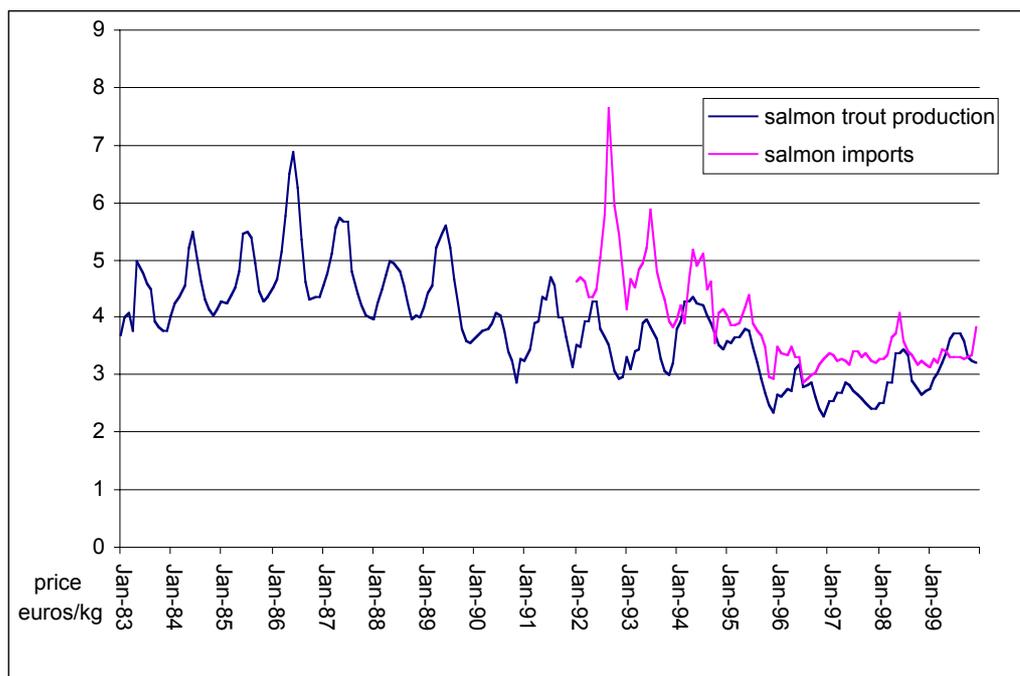
During the past decade the Finnish seafood industry has undergone major changes. The first of these changes is due to the removal of trade barriers to the importation of fresh salmon, which has brought a subsequent increase in imports of fresh salmon over the second half of the 1990's (Setälä et al 1998, Vihervuori 2001). The other change has been increased concentration along the seafood value chain.

At present the Finnish salmon market comprises mainly of two fish species, domestically farmed salmon trout (rainbow trout of 1-3 kilos marketing size) and imported salmon from Norway. Up until the early 1990's the salmon market was dominated by domestic salmon trout. This was due to restrictions on the importation of fresh salmon into Finland.

Although small quantities of imported frozen salmon fillets have been allowed into Finland, and around 10 per cent of domestic production of salmon trout is exported, the salmon market in Finland was largely isolated from outside competition prior to 1992.

Since the freeing up of trade barriers, imports of fresh salmon, mainly from Norway, have grown enormously to represent around a third of the total market for salmon and salmon trout in Finland. This has had the effect of pushing down the prices paid for salmon trout (figure 1), as salmon trout is increasingly being substituted for by salmon at the wholesale and retail level in Finland.

Figure 1: Prices for domestic salmon trout production and salmon imports in Finland.



At the same time as imports of salmon have been growing, relationships along the value chain have been changing. Fewer and larger operators are undertaking the delivery and marketing of salmon and salmon trout. This is due both to the increased dominance of supermarkets in retail sales, and also to innovations in processing, transports, distribution and logistics, that increase the efficient scale of operation. In addition, the retail sector in Finland has become increasingly concentrated. In 2001 the market share of two biggest retail chains was about 70 percent of total sales of consumables (A.C. Nielsen 2001).

The production sector for salmon trout has not concentrated as quickly as the other stages in the value chain. Hence, the scale of operation is still made up of many small producers. This is, in part, due to the restricted environmental license policy, which has effectively prevented the growth of fish farms. However, a few companies have grown through acquisition of fish farming sites.

The scale of operation is smaller for salmon trout farms in Finland, than in other countries, especially the major competitor Norway, where salmon farming is dominated by a few, large scale, operations. As wholesalers in Finland can choose whether they buy salmon trout from domestic processors, or import salmon, they are in a strong market position relative to the smaller domestic producers. In this sense the domestic salmon producers are price takers. Whereas in the case of salmon, wholesalers must pay the world price as determined in what Asche, Bremnes and Wessells (1999) refer to as a 'global' market for salmon.

In this paper we examine the relationship between prices along the value chain for salmon and salmon trout with the aim of determining whether agents are competitive at different points along the chain. In the instance where agents are competitive, and hence margins are constant between different levels of the value chain, we will calculate the value of this margin.

The methodology to be used in testing the relationship between prices in the value chain for salmon and salmon trout is based on cointegration techniques and the Law of One Price (LOP). Cointegration methodology has been widely applied in seafood market delineation studies (Asche, Salvanes and Steen 1997, Asche and Steen 1998, Clay and Fofana 1999, and Jaffry, Pascoe and Robinson 1999) but there are only a handful of other studies where cointegration methodology and the LOP have been used to look at relationships along the value chain (see Asche, Bremnes and Wessells 1999, Asche, Hartmann and Jaffry 2000).

In order to qualify the results of the quantitative analysis described above, key actors along the value chain for salmon and salmon trout in Finland were interviewed.

The paper will be organised as follows. In the next section a brief overview of the market for salmon and salmon trout in Finland is given. In section 3 the theory of derived demand as it is applied to measuring margins along the value chain will be presented. In section 4 a description of the techniques of cointegration and the application of the LOP is given. In section 5 an overview of the organisation of the value chain for salmon and salmon trout is given, along with a description of the data to be used in conducting the analysis. Next, the results from the analysis will be presented. Finally, in section 6, a brief discussion of the results is undertaken and some concluding remarks are made.

2. The market for salmon and salmon trout in Finland

Salmon and salmon trout are important products in the Finnish seafood market. By the end of the 1990's the market share of salmon and salmon trout in quantity terms was about one third of the total seafood market, while at the beginning of the 1980's it was under ten percent. Over time salmon and salmon trout have replaced traditional fisheries products such as Baltic herring, which dominated the Finnish market up until the early 1980's.

Salmon trout is the most important species in Finland with a production of around 15,000 tonnes in 1999, and consumption at around two thirds of the market for salmon and salmon trout combined. This production is down from its peak of 19,000 tonnes in 1991 (figure 2). This is due, in part, to competition from Norwegian imports of salmon. This competition is fairly recent, as up until 1993 restrictions were placed on imports of salmon into Finland. In 1999 Finland imported some 8,000 tonnes of salmon from Norway.

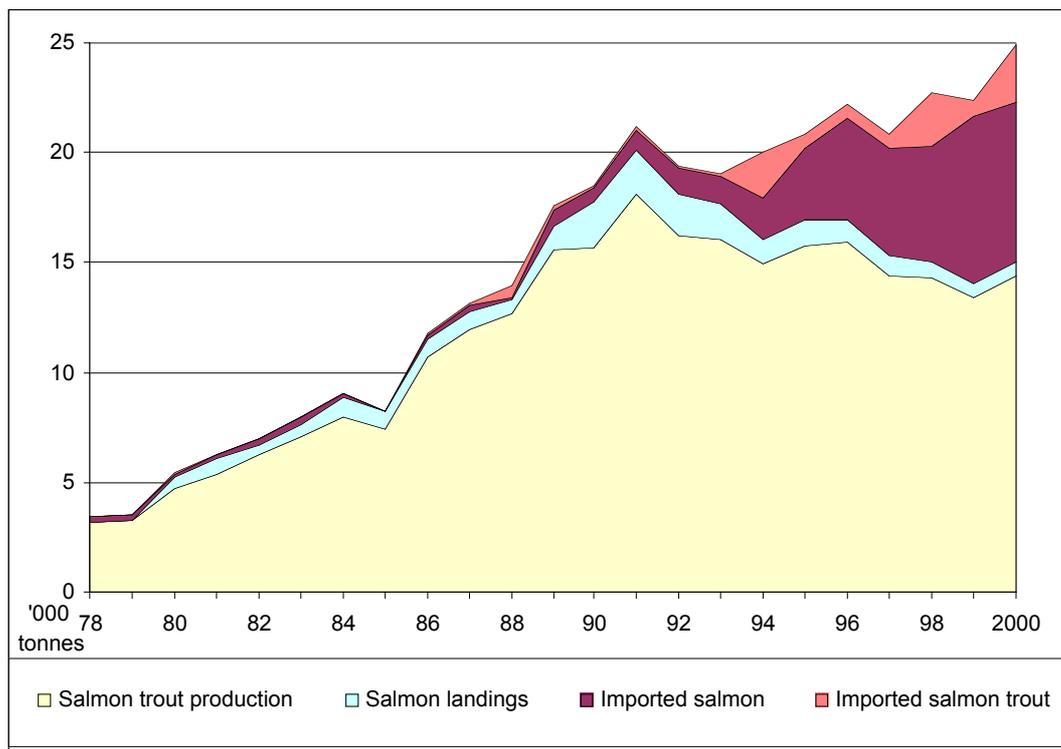


Figure 2: Development of the salmon and salmon trout market in Finland 1978-2000

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 (Guilloteau and Le Grel, 2001).

The structure of the value chain for salmon and salmon trout in Finland has changed. In the 1970's the role of fish wholesalers, fishmongers and specialist fish stores was very central. By the 1980's fish farming had enabled a steady supply of fresh fish, which encouraged retail chains to invest in fresh fish counters. Already by the end of 1980's 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 1990's 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 70 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. As the number of multifunctional fish wholesalers in Finland has increased, the role of traditional fish wholesalers has changed to undertaking a subcontracting role for the larger wholesalers. The combined market share of six biggest fish wholesale companies is over 50 percent of the total fish market.

3. Theoretical background

For most agricultural and seafood products there are intermediaries between the primary producer and the consumer, such as processors and retailers. Hence, changes in consumer demand will, in general, be distorted down the value chain, so that derived demand for the primary product differs from consumer demand. However, when prices are proportional along the value chain, as was demonstrated in *Asche et al* (1998), consumer demand elasticities and derived demand elasticities will coincide. The latter case is an example of a competitive market, i.e. all changes in costs for the seller will be fully passed on the next level in the value chain, and long-run profits for the firms will be zero (Hirsleifer and Hirshleifer 1998). In the former case, the intermediaries have their own production technologies and have possibilities to reduce the cost change by substituting the primary product input for the marketing input. In this case price pass through may be less than perfect.

If prices are proportional along the value chain, i.e. there is perfect price pass through, then an intermediaries production technology is characterised as having only one variable input. This condition 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. In the primary industries, especially in fresh fish trade the primary good is often the main cost factor in the chain. A pricing strategy based on some mark-up rule to cover all fixed costs is therefore not unreasonable. However, if this is the case, all marketing costs will be fixed costs.

A special case of perfect price pass through can occur when there is only one variable input factor, but the margin changes over time due to technological change. An important characteristic for many value chains is that there has been substantial technological innovation in distribution and logistics. As it is likely that there are at least economies of scale locally in transportation, logistics and other marketing services, one would expect margins between prices at different levels of the value chain to decline in competitive markets if technological change is present.

In the above two cases we have identified conditions for which there is perfect pass through, and an intermediaries production technology is characterised as having only one variable input. However, when the intermediaries have substitution possibilities, i.e. there is more than one variable input, the price pass through will be less than perfect. In the case of oligopoly or monopoly, intermediaries may exercise a certain degree of market power. It is not possible when testing for price proportionality to prove that market power is used, or if the intermediaries are competitive but applying more than one

variable input factor. This is because the test for proportionality is a test for whether the price transmission elasticity is equal to one against the alternative that it is less than one.

4. Material and methods

4.1 Cointegration and the law of one price

It has been observed that most macro-economic time series data are inherently non-stationary. That is, their means, variances or co-variances vary over time. Regressing such non-stationary time series can often lead to spurious correlation, where strong relationships between two or more variables is caused by statistical fluke or model specification issues rather than by meaningful underlying causal relationships. As a result an alternative method for testing for the relationship between prices needs to be used. Cointegration analysis permits inference of causal long run relationships between non-stationary variables and has become the most commonly used methodology for delineating markets (Ardeni 1989; Goodwin and Schroeder 1991; Gordon, Salvanes and Atkins 1993; Asche, Salvanes and Steen 1997; Perez Agundez *et al* 1999). The economic interpretation of cointegration is that “if two (or more) series are linked to form an equilibrium relationship spanning the long-run, then even though the series themselves may contain stochastic trends (i.e., be non-stationary) they will nevertheless move closely together over time and the difference between them will be stable (i.e., stationary)” (Harris 1995, p.22). When cointegration is verified, variables exhibit stable long run relationships, which indicates that a price parity equilibrium condition exists and variables are part of the same market.

4.2 Testing for stationarity

A prerequisite for undertaking cointegration tests is to verify that the series is, in fact, non-stationary and to ascertain the variables’ integration order.

The most commonly used test for determining whether a series is nonstationary is the Augmented Dickey-Fuller (ADF) unit root test. In this test, a null hypothesis is imposed that the data are non-stationary (ie. contain a unit root) against the alternative hypothesis of being a stationary variable.

Mathematically, the ADF can be expressed as testing $H_0:\alpha_0 = 0$ against $H_1:\alpha_0 < 0$ from the following general model:

$$\Delta Y_t = \alpha_0 \cdot Y_{t-1} + \sum_{i=1}^{p-1} \alpha_i \cdot \Delta Y_{t-i} + c + \delta \cdot t + \eta_t \quad \text{with} \quad \eta_t \sim IID(0, \sigma^2) \quad (1)$$

Differencing a non-stationary variable generally results in a stationary variable. However, sometimes a series must be differenced several times before it becomes stationary, although it is argued that this procedure may lead to the loss of short-run information. If a series is differenced d times before it becomes stationary, thus containing d unit roots, it is said to be integrated of order d and is denoted as being $I(d)$. Variables that are stationary in their levels, ie. $I(0)$ should be discarded from cointegration analysis. In most cases it is not strictly necessary for all the variables in question to have the same order of integration (Harris 1995).

4.3 Testing for cointegration

There are many alternative tests for cointegration, but it is well documented that the multivariate vector regression (VAR) approach developed by Johansen (1988) performs better than the single equation approach and other multivariate methods in detecting cointegration. This methodology has become widely used in most recent market delineation studies. See, for example, Clay and Fofana (1999); Perez Agundez *et al* (1999) and Asche and Steen (1998).

The multivariate approach developed by Johansen starts by defining a vector of n potentially endogenous variables Z_t . It is assumed that Z_t is an unrestricted VAR system with up to k -lags:

$$Z_t = A_1 Z_{t-1} + \dots + A_k Z_{t-k} + \Phi D_t + \mu + \varepsilon_t \quad (2)$$

where A_i is an $n \times n$ matrix of coefficients, μ is a constant, D_t are seasonal dummies orthogonal to the constant term μ and ε_t is assumed to be an independent and identically distributed Gaussian process.

Equation (2) can be reformulated in vector error-correction (VECM) form by subtracting Z_{t-1} from both sides:

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + \dots + \Gamma_{k-1} \Delta Z_{t-k+1} + \Pi Z_{t-k} + \Phi D_t + \mu + \varepsilon_t \quad (3)$$

where, $\Gamma_i = -(I - A_1 - \dots - A_i)$, ($i=1, \dots, k-1$), and $\Pi = -(I - A_1 - \dots - A_k)$.

The system of equations specified in (3) now contains information on both the short-run and the long-run adjustment to changes in Z_t . The rank of Π , denoted as r , determines how many linear combinations of Z_t are stationary. If $r=N$, the variables in levels are stationary; if $r=0$ so that $\Pi=0$, none of the linear combinations are stationary. When $0 < r < N$, r cointegration vectors, or r stationary linear combinations of Z_t exist. In this case one can factorise Π ; $\Pi = \alpha\beta'$, where α represents the speed of adjustment to equilibrium and β is a matrix of long-run coefficients and contains the cointegration vectors. Determining how many cointegration vectors exist in β consequently amounts to testing for cointegration.

Johansen and Juselius (1990) show that after undertaking appropriate factorising and by solving an eigenvalue problem it is possible to test for the number of significant cointegration vectors using two different tests. The first is the trace test (η_r), which is a likelihood ratio test for at most r cointegration vectors using

$$\eta_r = T \cdot \sum_{i=r+1}^N \ln(1 - \lambda_i), \text{ where } T \text{ is the number of observations and } \lambda_i \text{ are the eigenvalues which solve}$$

the eigenvalue problem. The second is the maximum eigenvalue test (ξ), which is a test of the relevance of column $r+1$ in β using $\xi_r = -T \ln(1 - \lambda_{r+1})$.

As the trace test tends to accept cointegration too often (Johansen and Juselius 1990), we will accept cointegration in accordance with the maximum eigenvalue test. Maddala and Kim (1998) suggest that the maximum eigenvalue should be corrected for the number of estimated parameters (degrees of freedom)¹.

4.4 Proportionality

The LOP is usually tested for by running the regression:

$$\ln p_t^1 = \ln \gamma + \beta \ln p_t^2 + \varepsilon_t \quad (4)$$

and testing the null hypothesis $H_0: \beta = 1$, where p_1 and p_2 are the prices of goods 1 and 2 respectively.

If $\gamma = 0$ and $\beta = 1$, then the two prices are equal. This is the strict version of the LOP. If $\gamma \neq 0$, but $\beta = 1$, the prices have a proportional relationship, but their levels differ due to factors such as transportation costs and quality differences.

¹ The Johansen λ_{\max} test statistic should be corrected for the number of estimated parameters. This is done by multiplying it by $(T - np) / T$, where T is the number of observations, n is the number of variables, and p is the number of lags (Maddala and Kim 1998, p. 219).

When the price series under observation are nonstationary, it is not possible to test for the LOP using this method. Instead, one must use cointegration theory, and the Johansen procedure (see section 2.2). Restrictions are imposed on the parameters in the cointegration vectors β , using likelihood ratio tests².

In this paper we are testing for the existence of a common cointegrating vector for two price series. Hence, there are two price series in the Z_t vector. Provided that the price series are cointegrated, the rank of $\Pi=\alpha\beta'$ is equal to one and α and β are 2×1 vectors. A test of LOP is then a test of whether $\beta' = (1, -1)$.

4.5 Technological change

If technological change is an important factor in describing the relationship between prices then a trend term will enter into the short run relationship between the prices. Equation 4 reformulated with a trend term then becomes:

$$Inp_t^1 = \ln \gamma + \beta Inp_t^2 + \varphi_T + \varepsilon_t \quad (5)$$

Where φ_T represents the trend term. It is still the β parameter that is of interest, since this contains the information on the price pass through. However, as noted in section 2, the trend term makes the mark-up nonconstant.

4.6 Testing for weak exogeneity of prices

Using the Johansen procedure we can also test for weak exogeneity of prices. In order to do this we impose restrictions on parameters in the α vector using likelihood ratio tests. If a row in α contains only zeros (in our case one element since α is a column vector) the price in question will be weakly exogenous. That is, it will determine the other price. Testing for weak exogeneity amounts to testing the null hypothesis $H_0: \alpha = 0$.

5. Data and time series properties

Analysis of the relationship between prices along the value chain for salmon and salmon trout is undertaken in two stages. First, the relationship between prices for salmon and salmon trout is tested horizontally, at the same points along the value chain, to determine if the two species are substitutes. Second, the relationship between prices is tested vertically along the value chain. 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 (Figure 3).

To verify the results of the quantitative analysis key actors along the value chain for salmon and salmon trout in Finland were interviewed. The interviewees were representatives of big multi-functional fish wholesalers, retail chains and organisations of fish traders and fish farmers.

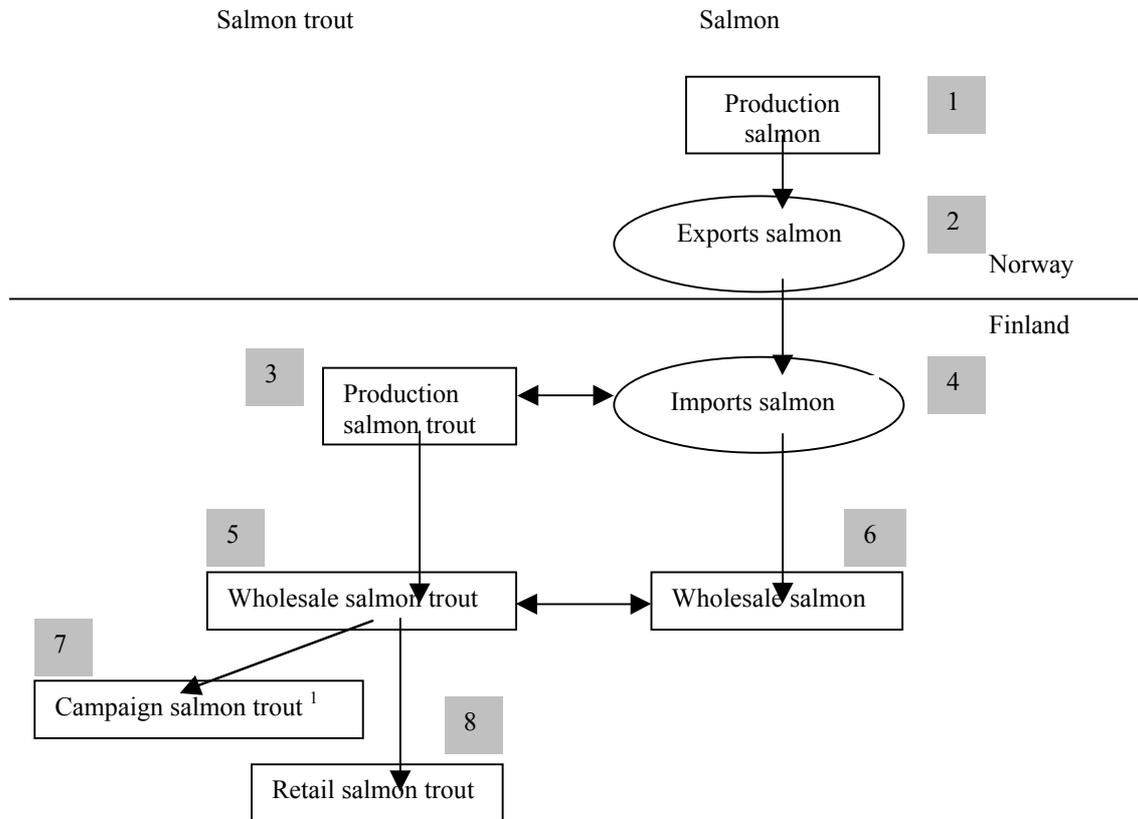
² The null restrictions on the long run parameters in $\hat{\beta}$ are tested using a likelihood ratio test. First the model is estimated in its unrestricted form and the unrestricted eigenvalues obtained, $\hat{\lambda}_1 > \dots > \hat{\lambda}_r$, where $\hat{\lambda}_i$ is the eigenvalue of the i^{th} vector from the unrestricted cointegrating space. Then the model is estimated in its restricted form and the restricted eigenvalues obtained, $\hat{\lambda}_1^* > \dots > \hat{\lambda}_r^*$. Finally the two sets of eigenvalues are compared by calculating the test statistic given by;

$$LR^* [r(N-s)] = T \sum_{i=1}^r \ln \left\{ -\hat{\lambda}_i^* / (1 - \hat{\lambda}_i) \right\}$$

The test statistic has an asymptotic chi-square

distribution with $r(N-s)$ degrees of freedom, where r is the number of cointegrating vectors, N is the dimension of the unrestricted cointegrating space and s is the dimension of the restricted space.

Figure 3: Value chain for salmon trout and salmon



Notes: 1. Retail campaigns are one off sales campaigns run by the same stores that sell salmon and salmon trout at normal prices. Salmon trout is sold on offer in order to attract people in stores. They are usually run about once a week.

The price series at different levels of the value chain (figure 3) were analysed over the time period January 1995 to December 1999. The data sources and time series properties (i.e. stationarity tests) for each price series corresponding to the numbers given in the figure above are presented in Appendix 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 statistically dependent on the lag length chosen and there is a tendency at lower lags that some of the series are stationary in the levels.

Two types of retail prices were used for the analyses of salmon trout chain: retail prices and campaign prices. Retail prices for salmon were not available. The data is shown in more detail in Figures 4, 5 and 6.

Figure 4: Prices for whole gutted salmon imports, domestic salmon trout production and wholesale salmon and salmon trout.

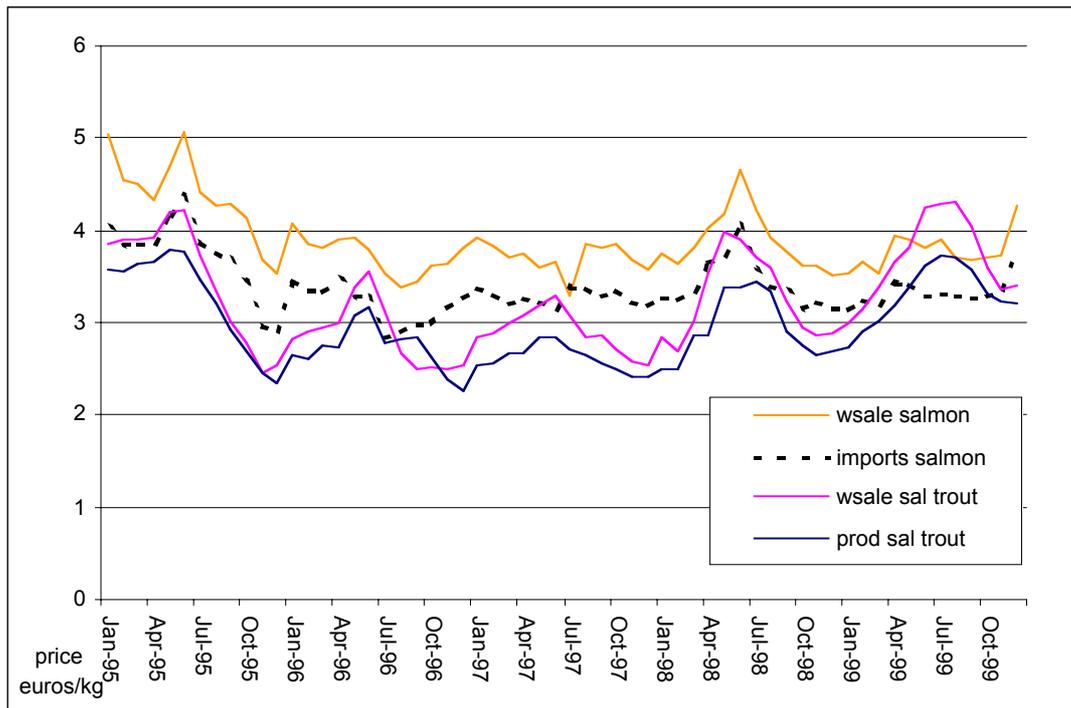


Figure 5: Prices for salmon trout along the value chain in Finland

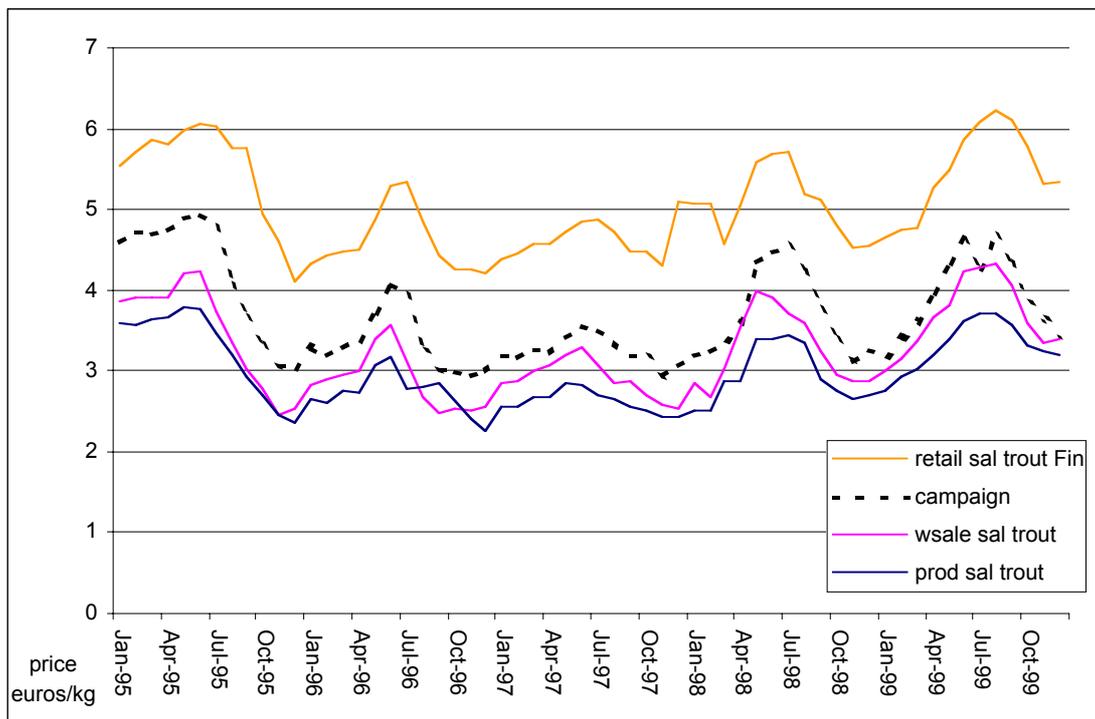
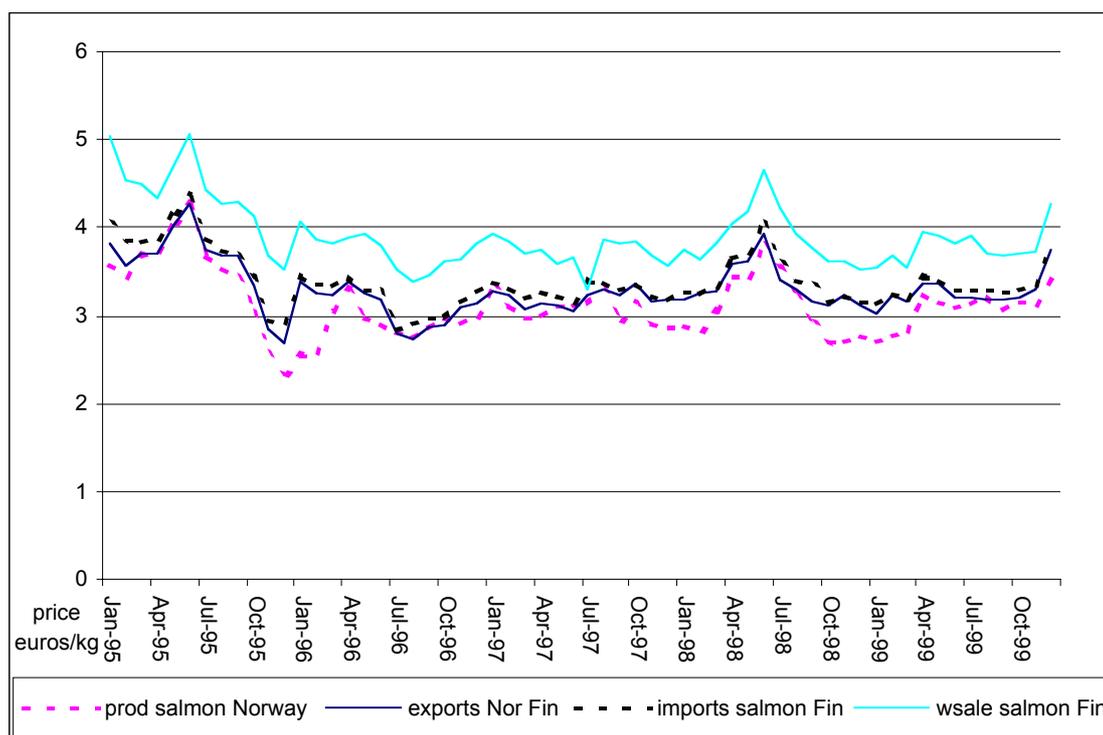


Figure 6: Prices for salmon along the value chain from Norway to Finland



6. Results and discussion

The results of the empirical analysis will be presented in two stages. First, a summary of the results of the cointegration, proportionality and exogeneity tests will be presented. Second, in the instance where prices are found to be proportional a margin will be calculated. A more detailed table of results from the cointegration tests are given in Appendix 2.

All the prices between salmon and salmon trout at the same point along the value chain were cointegrated confirming that the two species are substitutes (table 2). However, the price series were not proportional indicating that the relationship between prices for the two species at the same point in the chain have changed. 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. Given this, there would be asymmetry in price movements as import prices could not decrease by the same extent as producer prices, but both could increase.

Table 2: Results from analysis of the salmon and salmon trout value chain in Finland

Test	Price 1	Price 2	Cointeg -ration	Proportio -nality	Trend -perfect price transmi ssion	Exogenous price
Horizontal	Producers salmon trout	Importers salmon	Yes	No		Neither

Analysis: Salmon trout/ Salmon	Wholesalers salmon trout	Wholesalers salmon	Yes	No		Neither
Vertical analysis: Salmon trout	Producers Wholesalers Wholesalers	Wholesalers Campaign prices Retailers	Yes Yes Yes	Yes No	 Yes	Wholesalers Wholesalers Wholesalers
Vertical analysis: Salmon	Producers Exporters Importers	Exporters Importers Wholesalers	Yes Yes Yes	Yes Yes Yes		Exporters Neither Importers

The results of the vertical analyses indicate that the price series at all points along the value chain for salmon and salmon trout are cointegrated (table 2). However, it is only at points lower down the chain that prices are proportional, and the value chains for the two species are highly competitive, i.e. in the case of salmon trout, between farm gate and wholesale, and for salmon, from farm gate in Norway through to wholesale in Finland.

It was not possible to verify the existence of a competitive market higher up in the value chain for salmon trout, i.e., between wholesale and retail prices, and wholesale and campaign prices. However, in the case of wholesale and campaign prices it was possible to find perfect price transmission with a trend. From figure 7 we can clearly see that the margin between the two prices has been decreasing over time. The declining margin may be due to cost savings in the logistic and market services, or to increased competition from salmon.

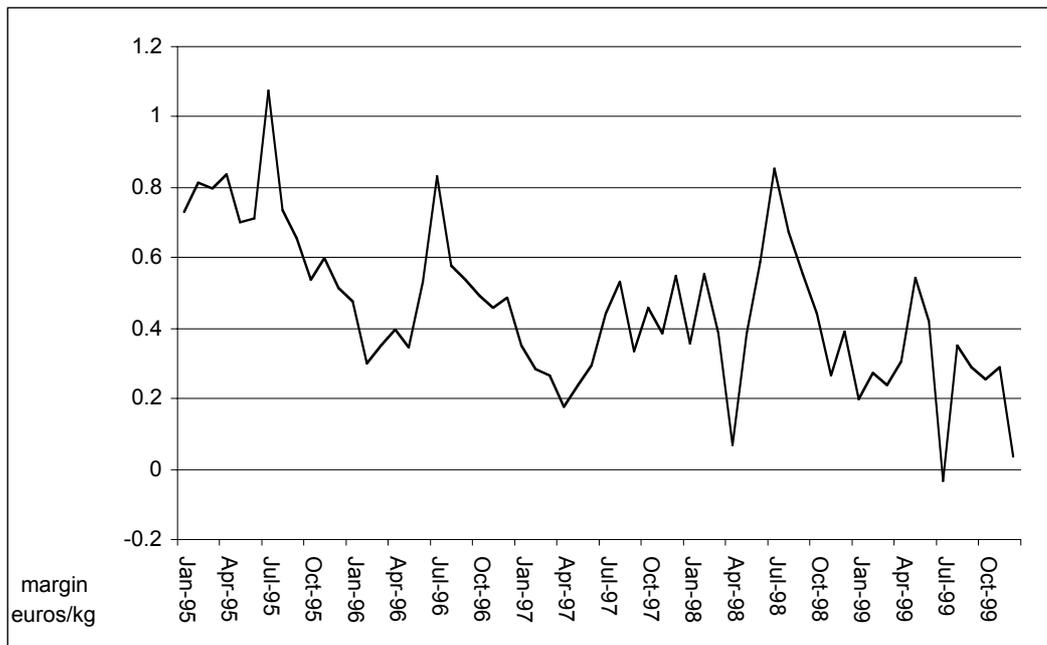


Figure 7: Margin between wholesale and campaign prices for salmon trout

The results of the exogeneity tests confirm that wholesalers are in a central market position relative to domestic 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. This is because the wholesalers operate between producers and retailers and decide whether to buy domestically produced salmon trout or imported salmon. They also decide what to do with the raw material, i.e. whether to sell it processed or unprocessed. But as mentioned above the wholesale trade is competitive, so the wholesalers do not have market power. They rather operate as auctioneers between producers and retailers and transmit the market information between them. This observation was supported by the interviews conducted as part of this study. One wholesaler described the situation: “We act as auctioneers: we pass on the information from retailer to producers on how much the market is willing to pay. The producers then have to decide to either accept, or not to accept, our offer. Normally, the deal is realised sooner or later, if not today, probably tomorrow”.

It was not possible to find proportionality between prices at lower stages of the value chain for salmon trout in Finland, i.e. between wholesale and retail (table 2). This would suggest that there is a possibility for retailers in Finland to exercise a certain degree of market power. However, we cannot conclude this on the basis of statistical tests alone. This result was also supported by the interviews. According to wholesalers, the two biggest retail chains have recently introduced an offering system which intensifies competition between fish wholesalers. Wholesalers have to give new offers weekly for fresh fish products. The wholesaler with the lowest price is chosen as the main supplier of the week.

The salmon value chain from Norwegian producers to wholesalers in Finland was found to be competitive. 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 result indicates that prices on world markets determine the wholesale price in the Finnish salmon market. This result was supported by the interviewees and is in line with previous studies, which suggest that salmon has a single world market price (Asche and Sebulonsen 1998, Asche, Bremnes and Wessells 1999, Asche 2001).

Descriptive statistics for the salmon and salmon trout value chain are presented in table 3 .

Table 3 : Descriptive statistics and margins for the Finland salmon and salmon trout value chain (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 salmon trout		2.95	0.43	15			
		Wholesalers salmon trout	3.23	0.54	17	0.28	9	Yes
		Wholesalers salmon trout	3.23	0.54	17			
		Retailers salmon trout	5.04	0.60	12	1.81	56	
		Campaign prices salmon trout	3.68	0.61	16	0.45	14	
Vertical analysis: Salmon	Producers salmon		3.11	0.37	12			
		Exporters salmon	3.29	0.31	9	0.18	6	Yes
		Exporters salmon	3.29	0.31	9			
		Importers salmon	3.39	0.31	9	0.10		Yes
		Importers salmon	3.39	0.31	9			
		Wholesalers salmon	3.89	0.38	10	0.50	15	Yes

The coefficient of variation reported in table 3 is the standard deviation of each price series divided by its mean. This 'coefficient of variation' provides a measure of the degree of price volatility along the value chain. Normally, price volatility tends to be less at the retail level relative to the producer level, i.e. supply shocks at the primary level are larger than demand shocks at the retail level. However, this common trend is not clear for the value chains in this study. Volatility does not vary remarkably within the value chains. One exception is the retail price of salmon trout, which clearly has a lower coefficient of variation than campaign prices, and prices at the producer or wholesale level. This result suggests that retailers have two pricing strategies. The first pricing strategy is an ordinary retail price which applies during the week. This price is high and responds less to changes in supply, because retailers try

to stabilise it. The second pricing strategy is a campaign price which applies on the weekend. This price is low in order to attract masses of people to stores to buy consumables for the weekend.

The series for salmon are clearly less variable over the long run than the series for salmon trout. There are at least two explanations for this. 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 (table 3). Another interesting fact is that the margin between importers and wholesalers of whole salmon is higher than the margin between production and wholesale of whole salmon trout. This may indicate that there are higher intermediate costs between import and wholesale of salmon, or that a premium is paid by wholesalers for salmon over 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. This could have been the case in the beginning of the study period, but according to interviews of wholesalers, the profit is about the same for both fish species.

At lower levels of the value chain for salmon and salmon trout there is price proportionality. The corresponding margins in table 3 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 the intermediaries.

7. Conclusion

On the basis of this study following conclusions can be made. Salmon and salmon trout markets are highly integrated. The value chains for both fish species are competitive from the production level to wholesale level. This conclusion could not be confirmed at the retail level. However, the price transmission was perfect with a trend when salmon trout was sold through campaign sales.

The role of fish wholesalers in Finland is central in the salmon trout value chain. They operate as auctioneers between producers and retailers. In addition, wholesale prices are the leading prices in transmitting market information to other levels of the value chain. Our findings support the idea that world market price of salmon is transmitted to Finnish salmon markets.

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Appendix 1. Data sources and time series properties for price series in the salmon and salmon trout value chain

	Type of series	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)
1	Ex-farm price of salmon In Norway	NSL	-2.64	-3.02	-4.72**	-4.54**
2	Export prices salmon from Norway to Finland	Norwegian Trade Statistics	-1.30	-2.12	-2.70	-4.94**
3	Ex-farm price of salmon trout in Finland ¹	Finnish Fish Farmers' Association	0.23	-1.52	-2.16	-4.68**
4	Import prices salmon from Norway to Finland ²	Finnish board of customs	-1.76	-2.49	-4.96**	-4.98**
5	Wholesale price of whole fresh salmon trout in Finland ³	Finnish wholesale companies	0.22	-2.63	-5.34**	-6.01**
6	Wholesale price of whole fresh salmon in Finland ⁴	Finnish wholesale companies	-2.22	-2.32	-2.90	-4.79**
7	Retail prices salmon trout Finland ⁵	Statistics Finland	-0.85	-2.50	-4.85**	-4.90**
8	Campaign prices salmon trout Finland ⁶	Finnish Fish Farmers' Association	-0.69	-2.64	-2.46	-5.23**

Notes: 1. and 2. Production and import prices are quantity weighted monthly means. Import prices include cost, insurance and freight. 3. and 4. Wholesale prices are an arithmetic mean of prices collected from five national wholesale and processing companies (corresponding 50 per cent of wholesale volume in Finland). 5. Retail prices are an arithmetic mean of prices collected from 2000 food stores around Finland by Statistics Finland. 6. Campaign prices are collected from newspapers by Finnish Fish Farmers Association.

Appendix 2: Detailed results from cointegration and proportionality tests for the salmon and salmon trout value chain in 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 salmon¹								
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)
Producers and wholesalers salmon trout²								
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 salmon trout and wholesalers salmon³								
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)
Wholesalers and retailers salmon trout⁴								
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 trout⁵								
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 Norway⁶								
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 Finland⁷								
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 salmon⁸								
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 12th 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 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. **3.** 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. **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.