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ABSTRACT

When Anti-Dumping Measures Lead to Increased Market Power: A Case Study of the European Salmon Market*

In this paper we apply the Bresnahan-Lau (1982) model to test for market power in the European distribution of salmon. In this particular setting, the model also incorporates a test of whether dumping takes place over time. Utilising data at the import level, derived demand equations are specified rather then consumer demand. From 1997 a so-called salmon agreement that implied minimum prices, a growth ceiling and a feeding restriction program for Norwegian farmers was imposed. Here we test whether the agreement resulted in an increase in the Norwegian market power. The results suggest that Norway did not have market power prior to the salmon agreement, and we find no indication that dumping was taking place. However, the agreement led to Norwegian market power after 1997. It is interesting to note that the agreement was initiated to prevent anti dumping duty of 13% that Norwegian farmers would have to pay otherwise. The increase in mark-up from imposing the agreement is found to be in the order of 14-15%, suggesting that the Norwegian farmers saved a fee of 13% and gained a markup that was even higher.

JEL Classification: C22, C32 and L13
Keywords: anti-dumping, market power and salmon markets

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Introduction

Recently, the use of anti-dumping measures has increased substantially (Prusa, 1996). Most anti-dumping measures have in common that they are aimed at one or a group of exporters, but not all exporters to the market in question. The introduction of anti-dumping measures will then reduce competition in a market by reducing the number of exporters that are allowed to serve the market. Possible effects are well understood in theory, as anti-dumping measures can decrease imports from named countries, increase imports from non-named countries and increase import prices. The magnitude of these effects will depend on the market structure in each specific case. Less attention has been given to the fact that anti-dumping measures can act as a coordinating device that force the industry in a country to exploit market power when it is found guilty in a dumping case, and it can also be a cause of pricing to market (Golberg and Knetter, 1999). Very few studies address this issue empirically. Nieberding (1999) analyse several U.S. industries using a Lerner index approach and observed firm level price cost margins. He finds evidence of increased mark-up for U.S. firms receiving protection under the antidumping statute. However, to our knowledge there exist no studies applying newer structural empirical approaches (Bresnahan, 1989) where observed data on price cost margins are unnecessary.

In this paper we apply the Bresnahan-Lau (1982) model to test whether anti dumping measures has enabled Norwegian exporters to exercise market power for farmed salmon following trade measures from the European Commission. Since data are available both before and after the trade restricting measures were imposed, the anti dumping measures work as a possible exogenous structural break in the market structure allowing us to formulate parametric tests for shifts in market power. The Bresnahan-Lau model provides an estimate of a markup parameter where its size is proportional to the level of market power, i.e., if it is *zero* no market power is found, if it is *one* we face a perfect cartel. Parameter estimates below zero is more problematic to interpret in this model since these suggest some kind of “super competition” where price is bellow marginal cost. However, using the model in a potential anti-dumping setting removes this interpretation problem, since “super competition” simply implies dumping bellow marginal cost. Hence, the Bresnahan-Lau model allows us both to tests for market power and potential dumping in our case, as it allows a test of whether the export price is bellow marginal cost. In a trade context, markup parameters of the “wrong” sign accordingly have a clear economic interpretation.

Steen and Salvanes (1999) found that Norway had market power in the short run but not in the long run for salmon exports to the EU, utilising data up to 1992, where a common sales organisation for the Norwegian farmers where the coordinating device. The common sales organisation that could coordinate the exporters was dissolved in November 1992, which led to an industry structure that should be closer to competitive with many independent exporters (more then 100). In 1996 a scheme of national feed quotas was introduced due to trade tensions with the EU to support EU policies to stabilise salmon prices. The feed quotas set a maximum quantity of feed each farmer could use.[1] In 1997 an agreement, the so-called salmon agreement (Bull and Brittan, 1997) was signed between the EU and Norway. The main elements of the agreement is a ceiling on Norwegian export growth to the EU, a marketing fee and the opportunity for each Norwegian exporter to enter a minimum import price agreement with the EU to avoid an anti-dumping duty of 13%. All exporters actually carrying out exports of salmon to the EU does so under this agreement.

[1] The feed makes up more then 50% of the salmon farmers cost and is the main input factor in the growth phase for the fish (Guttormsen, 2002).

In this paper we use data for the period 1993 through 1999 to analyse whether the industry indeed became competitive after the sales organisation was dissolved and if it in fact dumped salmon into the EU in the period 1993 – 1996. Furthermore, we investigate whether the salmon agreement and the Norwegian feeding program resulted in oligopoly profits for the Norwegian industry. We assume that the minimum import price agreement together with the feeding quotas acted as a co-ordinating device where Norway thereby reduced total quantity supplied to the EU. This has potentially led to Norway exercising market power given that the Norwegian farmers acted without any coordination prior to this regime.

The Bresnahan-Lau model is formulated in a dynamic fashion. Furthermore, in contrast to the most common specifications, we model demand as derived demand rather then consumer demand since our data are at the import level. Using a dynamic partial adjustment model we find market power the period following the salmon agreement, but not for the earlier period. The estimated long-run markup for the salmon agreement period is found to be three times higher than the short run markup, but is significant only on a 7% level. The short run markup for the agreement period is found significant on a 5% level, and is also higher in magnitude than what Steen and Salvanes (1999) found. The demand side is well behaved, indicating unit elastic demand.

This paper is organised as follows. In the next sections we give some background on the industry and the market before we discuss the Bresnahan-Lau model. In section 4 we show the empirical specification before we report the results in section 5. In the last section some concluding remarks are offered.

The industry and the market

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. From then on the availability of salmon increased substantially. In 1980 the total supply of salmon was about 500,000 tonnes, of which only 13,000 tonnes were farmed (Bjørndal, 1990). During the 1980s the landings of wild Pacific salmon increased substantially to historically high levels; in the 1990s, these have been about 800,000 tonnes, although with much variation. 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 about 1.3 million tonnes in 2000, making the total supply of salmon about 1.9 million tonnes, or almost a quadrupling since 1980.

Figure 1 shows total aquaculture production, the real Norwegian export price and production cost.[2] 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 of the price in 1982. However, production costs have also declined and expansion has been possible because of substantial productivity growth (Asche, 1997). 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 (Kinnucan and Myrland, 2002).

It is also worthwhile noting that farmed salmon is produced in large quantities in only a few countries. With their 1999-shares in parentheses, Norway (46%), Chile (20%), the UK (14%) and Canada (8%) make up about 90% of the total quantity produced. Given that Canada and

[2] The markets for different species and product forms of salmon seem to be highly integrated (Asche, Bremnes and Wessells (1999) and Asche (2001). Therefore, there should be no problem to interpret the Norwegian export price as the global price of salmon.

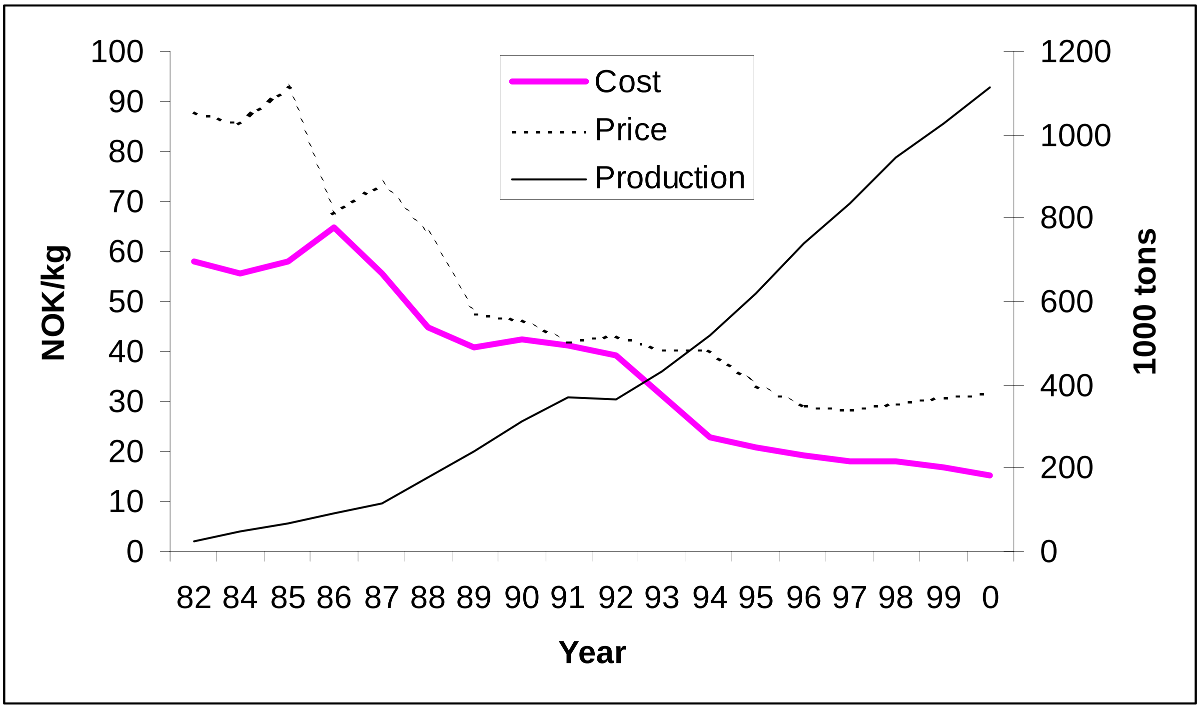

Figure 1. Global supply of salmon with real Norwegian export price and production cost, 1982-2000. Sources: Norwegian directorate for fisheries for production cost and the Norwegain Seafoods Export Council for quantity and price. NOK is Norwegian kroner.

the UK are members of respectively NAFTA and the EU, this has lead to a number of trade conflicts (Anderson and Fong, 1997, Asche, 1997). There have therefore also been several attempts to stabilise prices. However, this also immediately raise the issue of market power, as the named producers needs market power at least in the short run for countervailing schemes to work as intended in increasing prices. If not, the only observable effect will be loss of market share for the exporters facing the duty.

The main target has been Norway, not surprisingly given its dominant share of production, but recently there has been filed complaints against also Chilean producers. Norway as well as the second largest producer of salmon, Chile, faces anti-dumping duties in the US after being found guilty in dumping in respectively 1991 and 1997 (Asche, 2001). There have been filed dumping complaints against Norway in the EU four times, so far without finding Norway guilty.

To what extent a trade restricting measure aimed at a named group of producers achieves its objective in increasing domestic market prices is dependent on the market structure. If the named group of producers have market power a limitation of their supply will increase the price, while if they do not have market power, other producers will take over their market share. Steen and Salvanes (1999) finds that Norwegian producers had market power in the short run in the period up to 1992, when a common sales organisation could act as the coordinating agent. This result is caused by the fact that it takes more than a year from the decision to produce a salmon is made until the grown salmon can be marketed. Even with the possibility to coordinate Norwegian producers, the absence of long run market power then indicates that if they where given the time to increase their production, other producers could expand their production to such an extent that they took over the Norwegian market share. In the US salmon market, where Norway only had a small market share prior to the countervailing measures that where imposed on Norwegian salmon in 1991, Canadian and Chilean producers quickly replaced the Norwegian supply. Correspondingly, Norwegian salmon replaced Canadian and Chilean salmon in Japan after countervailing measures were imposed (Asche, 2001).

In November 1992 the Norwegian sales organisation was abolished, taking away the coordinating agency. One would then expect the possibility to exploit market power to disappear. Anecdotic evidence also indicates that the market became highly competitive. Following a complaint from Scottish producers Norway in 1996 imposed a regulatory scheme where each farmer was given a feed quota, *i.e.*, a limit on how much feed the farmer could use on an annual basis to limit production to help stabilising salmon prices in the EU. However, regardless of this regulation the European Commission found evidence that indicated a dumping margin for Norwegian farmers and exporters and in 1997 Norway and EU therefore entered a 5 year salmon agreement. This agreement limits the Norwegian exports to the EU, and it levies an additional marketing duty.[3] Furthermore, it gives the opportunity for each Norwegian exporter to enter a minimum import price agreement with the EU to avoid an anti-dumping duty of 13%. All exporters that export salmon to the EU do so under this agreement.

Both the feeding quotas and the five year agreement restricted the Norwegian production, and can be regarded as limitation of supply from all Norwegian farmers coordinated by the government. This agreement will increase Norwegian salmon prices in the EU if salmon where dumped, and potentially act as a new coordinating mechanism for Norwegian producers to obtain a margin above the competitive price. Relatively to the situation in 1990, the potential to exploit market power for Norway should have increased as total farmed production in these years almost quadrupled, while the number of potential production sites became limited.[4] Production is also becoming more concentrated as four countries, Norway, Chile, the UK and Canada produce more then 90% of the farmed salmon, and Norway remains the leading producer. As the production of farmed salmon increases the marked has also become more focused on fresh products, and transportation costs make Canadian and Chilean salmon uncompetitive in Europe. Hence, the European market is dominated by Norwegian and Scottish salmon although other producers also supply small quantities.

In this study we look at the trade between Norway and Denmark, the largest importer of Norwegian salmon using monthly data for the period 1993-1999. We have Norwegian export data from Statistics Norway and the farm gate price as the main cost variable for the exporters from the Norwegian Fish Farmers Association. We also have Danish trade statistics from

[3] The agreement can be found in Bull and Brittan (1997). See Kinnucan and Myrland (2002) for a discussion of the marketing fee and its effect.
[4] The large increase in farmed salmon production also reduces the potential of wild salmon supplies to restrict uncompetitive practices.

Statistics Denmark, as well as wage index. The exchange rate between Norwegian kroner and Danish kroner is from the Norwegian Central bank.

The Bresnahan Lau model

The demand side may be described by (Bresnahan,1982 and Lau, 1982);[5]

(1) $Q = D(P, Z; \alpha) + \varepsilon$,

where Q is quantity, P is price and Z is a vector of exogenous variables affecting demand. Normally this includes a substitute price and income as the demand is taken to be consumer demand. However, as we are investigating a relationship at the border, it is more appropriate to let the exporters face a derived demand schedule from the importers. The exogenous variables are then other prices in the importers optimisation problem. α is the vector of parameters to be estimated and ε is the error term.

The supply side is more complex. In a competitive market, price equals marginal costs, and we can write;

(2) $P = c(Q, W; \beta) + \eta$,

where W are exogenous variables on the supply side, e.g. factor prices, β the supply function parameters, and η is the supply error. Marginal cost is given by $c(\cdot)$. However, when firms are not price takers, perceived marginal revenue, and not price, will be equal to marginal cost. Instead of a supply curve we now may write a supply relation;

[5] This part is largely based on Steen and Salvanes (1999).

(2') $P = c(Q, W; \beta) - \lambda \cdot h(Q, Z; \alpha) + \eta$,

where $P + h(\cdot)$ is marginal revenue, and $P + \lambda \cdot h(\cdot)$ is marginal revenue as perceived by the firm. Hence, λ is a new parameter that may be interpreted as a markup parameter measuring the degree of market power. Under perfect competition, $\lambda = 0$ and price equals marginal cost. When $\lambda = 1$ we face a perfect cartel, and when $0 < \lambda < 1$ various oligopoly regimes apply. Alternatively one can say that λ is the percentage of monopoly marginal revenue perceived. A negative λ is when it appears interpreted as evidence of "super competition". This is of particular interest in a trade setting as it implies that the export price is bellow marginal cost, and accordingly that dumping is taking place. Hence, used in the present setting the model also allows a test of whether dumping occurs.

The general empirical problem in all market structure studies is how to identify λ. Bresnahan solved this by introducing variables that combine elements both of rotation and of vertical shifts in the demand curve. This is done by formulating an interaction term between *P* and *Z*, i.e., changes in a substitute price affects both the position and the slope of the demand curve. To provide the necessary intuition for the identification principle used, we formulate the simplest version of the static linear BL model. Assuming both demand and marginal cost to be linear, the demand function (1) can be written as; $Q = \alpha_0 + \alpha_P P + \alpha_Z Z + \alpha_{PZ} PZ + \varepsilon$, and the marginal cost function is; $MC = \beta_Q Q + \beta_W W$. The supply relation is now;

(3) $P = \beta_Q Q + \beta_W W - \lambda \left[\dfrac{Q}{\alpha_P + \alpha_{PZ} Z} \right] + \eta$,

since $MR = P + \left[Q / (\alpha_P + \alpha_{PZ} Z) \right]$. By treating α_P and α_{PZ} as known (by first estimating the demand equation), λ is now identified.[6] To see this, write the markup as $Q^* = -Q/(\alpha_P + \alpha_{PZ}Z)$. There are two included endogenous variables, Q and Q^* and there are two excluded exogenous variables Z and PZ in (3). Hence, λ is identified as the coefficient of Q^* based on the estimation of (3). The inclusion of the rotation variable PZ in the demand function is crucial for this result. The economic implication of including this rotation variable in the demand equation is that the demand function is not separable in Z. Lau shows that identification is possible as long as this is true, regardless of the functional form chosen.[7]

A Partial Adjustment specification of the Bresnahan-Lau model

Markets are dynamic. Firms recognise their own ability to influence market structure, and, thereby, the competition. With influence on the market structure, price and/or quantity become strategic decision variables. Steen and Salvanes (1999) propose a dynamic reformulation of the BL model in an error correcting model (ECM) framework, as there will often be adjustment costs associated with this process. Here we use a partial adjustment (PA) model. By including lagged observations of the endogenous variables, the PA framework also incorporates dynamic factors such as habit formation from the demand side and adjustment costs for the producer. The presence of habit formation in demand and adjustment costs in supply make static models inadequate (Lucas, 1967; Pollak and Wales, 1992). An additional argument in favour of the PA adjustment model is that it solves several of the features as also is solved in the ECM model, but it requires less parameters to be estimated. With limited data sets this feature can sometimes be crucial. In the model we focus on Norway's role as an aggregate producer, modelling Norway as a dominant firm that sets the profit maximising price. The BL model allows for identifying a mark-up measure, indicating the degree of market power exercised. The PA model provides a dynamic formulation of the oligopoly

[6] When using static models it has become standard practice to estimate the demand equation and the supply relation simultaniously. However, this is more difficult here since the long-run structure impose even more non-linearities on the problem.

[7] See Bresnahan (1989) for a discussion of this model. Several studies have applied this methodology in various disguises on several industries. For some of these see on banking; Gruben and McComb (2003), Shaffer (2002, 1993), Suominen (1994), Petroleum; Considine (2001), Cement; Rosenbaum and Sukharomana (2001), Cigarettes; Delipalla and O'Donnel (2001), Beef processing; Mauth and Wohlgenant (1999), Salmon; Steen and Salvanes (1999), Sugar; Genesove and Mullin (1998), Advertising; Jung and Seldon (1995), lumber; Bernstein (1994), Coconut oil; Buschena and Perloff (1991).

problem.[8] The salmon production process also possesses a feature that makes it necessary to apply a model that allows for differences in short run and long run behaviour. Due to the biological determined growth process salmon production is relatively fixed in the short run, it takes in the order of 1-2 years to put new salmon into the market. This suggests that there is scope for short run market power in this market, since competitors have restricted supply in the short run.

The demand function on partial adjustment form can be written as[9]

(4) $$Q_t = \alpha_0 + \sum_{i=1}^{k-1} \gamma_{Q,i} Q_{t-i} + \alpha_P P_t + \alpha_Z Z_t + \alpha_{PZ} PZ_t$$

where the long run parameters are given as:

(5) $$\theta_j = \alpha_j^* \Big/ 1 - \sum_{i=1}^{k-1} \gamma_{Qi}^* , \quad \text{and} \quad j = P, Z, PZ ,$$

e.g., the parameter θ_P measures the stationary long-run impact of P_t on Q_t. 1-γ^* is usually denoted as the adjustment speed and measures the impact on Q_t of being away from the long-run target; that is, $1 - \sum_{i=1}^{k-1} \gamma_{Qi}^*$ measures how fast firms can correct the errors of past decisions.

To identify the supply relation and λ, some of the demand parameters, e.g. price and interaction parameters, are needed. The natural candidates are the long-run parameters: θ_P and θ_{PZ}. Hence, the dynamic formulation of the supply relation in (3) is;

(6) $$P_t = \sum_{i=1}^{k-1} \phi_{P,i} P_{t-i} + \beta_Q Q_t + \beta_W W_t + \lambda Q_t^* ,$$

---

8 Since we do not include an explicitly modelled feedback mechanisms, we assume that the cartel maximises profits in each period, i.e., solves a succession of static problems.

9 We also investigated whether lags of the right hand side variables where important by testing whether ECM specifications could be reduced to partial adjustment specification. This was supported for the demand equation as well as the markup equation as Wald tests provided *p*-values of 0.143 and 0.915.

where

(7) $$Q_t^* = Q_t \Big/ \left(\theta_P + \theta_{PZ} Z_t\right)$$

and

(8) $$\Lambda = \lambda \Big/ 1 - \sum_{i=1}^{k-1} \phi_{Pi}, \; \beta_Q^* = \beta_Q \Big/ 1 - \sum_{i=1}^{k-1} \phi_{Pi}, \; \beta_W^* = \beta_W \Big/ 1 - \sum_{i=1}^{k-1} \phi_{Pi}$$

The PA -formulation provides both a short-run measure of λ: λ and a long-run measure, Λ. The supply relation in (6) incorporates adjustment costs and allows short-run deviations from the requirement that marginal cost should equal perceived marginal revenue. The short-run measure then provides the current period effect of a change in the associated right-hand side variable; in our case with monthly data, the first month. The long-run measure provides the effect after all adjustment costs has been incurred, and gives the total effect of the change in the associated right-hand side variable.

Empirical Specification

The product of interest is Norwegian fresh salmon sold in Denmark. To represent the exogenous *Z* vector we use a Danish industrial wage index, shifting the processing industry's demand for Norwegian fresh salmon.[10] Costs are represented by farm gate prices on fresh salmon. All prices are measured in Danish Kroner. Summary statistics for the variables used are reported in Table 1.

[10] We assume that output is separable in this problem. If not we should have included an output price if the importers were assumed to be a profit maximizers, or alternatively output quantity if the importers were assumed to be a cost minimizers. While this assumption seems restrictive at first glance, it can be defended if the importers can be characterised by constant returns to scale. This is a commonly made assumption for intermediaries' production technology dating back to Hicks (1957) who introduced the notion of derived demand. It is also often reasonable as there are many small intermediary firms competing for the input factor. This seems to the case for imports of salmon to Denmark. There are many importing firms using well known and easily replicable technologies as they are mostly only repackaging the salmon or carry out simple processing.

Table 1

Summary statistics[a]

Variable	Mean	Standard Dev.
Import price, Denmark	29.333	5.297
Import quantity	3981756	1747905
Export price	80.034	16.448
Producer price, Norway	25.965	3.446
Wage	95.381	4.469
N	84	

[a] All values are in Danish kroner.

However, before we formulate the equations to be estimated, some additional characteristics of the salmon market must be considered. Previous salmon demand studies show that seasonality is important in this industry, and seasonality is also clearly present in our data. Hence, in addition to the constant term seasonal dummy variables for five months, August to December are also included ($D_{t,i}$). Finally we include a linear time trend. The demand function in (4) may then be extended to:

$$(10) \qquad Q_t = \alpha_0 + \sum_{i=8}^{12} D_{t,i} + \gamma_{Q1} Q_{t-1} + \alpha_P P_t + \alpha_Z Z_t + \alpha_{PZ} P_t Z_t + \psi trend + \eta_t \,,$$

and the supply relation from (6) is now:

$$(11) \qquad P_t = \phi_{P,i} P_{t-i} + \beta_Q Q_t + \beta_W W_t + \lambda Q_t^* + \varepsilon_t$$

where W is farm gate price in Norway, and $Q_t^* = Q_t / \left(\theta_P + \theta_{PZ} Z_{t\,t}\right)$. Using farm gate prices implies that the markup that is estimated will mirror the exporters' possible market power. The EU has during the period we are analysing claimed that the markup and possible market power is found at the exporter level and not the farmer level (Bull and Brittan, 1997; Guillotreau and LeGrel, 2002). One of the arguments has been that the exporters can act co-ordinated, whereas the farmers face more competition when selling their salmon to the exporters.

As argued above, the imposed antitrust measures work as a possible exogenous structural break in the market structure. To implement parametric tests for a possible shift in market power in the Bresnahan-Lau model we augment the model with a mark-up term for the period the agreement has been imposed.

(11’) $$P_t = \phi_{P,i} P_{t-i} + \beta_Q Q_t + \beta_W W_t + \lambda Q_t^* + \lambda_{salm-agreem} Q^*_{salm-agreem,t} + \varepsilon_t$$

Where $Q^*_{salm-agreem,t} = (Q_t / (\theta_P + \theta_{PZ} Z_t)) \cdot D_{salm-agreem}$. The latter variable is an agreement period dummy that measures the effect of the salmon agreement regime, and that takes the value 1 during the regime. All prices and values are in Danish kroner, and the error terms are assumed to have the standard properties.

The estimation is done in two steps. To account for the simultaneity problem, (10) is estimated using an instrumental variable technique, two stage least squares (2SLS), using *W*, the exchange rate between Norwegian and Danish kroner and the salmon agreement dummy ($D_{salm-agreem}$). A potential simultaneity problem is present for farmed fish since farmers/exporters have an elastic supply curve (Steen, Asche and Salvanes, 1997). The instruments *W*, and $D_{salm-agreem}$ refer to the supply side in the identification of the demand function. In order to test the validity of the instruments we used *Sargan validity of instrument test.*[11] Then, after having calculated the Q^* variable, (11) is estimated using the same technique, with the German import price on smoked salmon from Denmark, a linear time trend and monthly seasonal dummies for the last quarter as instruments. The German price is

[11] The Sargan test statistics has an approximately Chi-square distribution with (*p*-*h*) degrees of freedom; *p* is the number of instruments and *h* is the number of regressors on the right hand side of the equation.

used since Germany is the most important market for processed (smoked) Danish salmon.

Empirical results

The demand function results are presented in Table 2. The centered R^2 is nearly 0.90.[12] The elasticities are reported in Table 3. The demand model predicts a short run own price elasticity of -0.84 and a long run elasticity of -1. Compared to earlier studies of this market the results seem reasonable. Steen and Salvanes found a long-run elasticity of -1.2 for export to France using an error correcting model. Since we are using a newer dataset, it seems reasonable to find a less elastic market as the demand elasticity for salmon has been decreasing in magnitude as the production has been increasing (Asche, 1996). The earliest studies using data for the 80s found elasticities in the order of -2.0 and above. However, as the industry has grown mature it is reasonable to approach a unit elastic demand. The elasticity with regard to the Danish industry wage is positive and in the order of 1.7-2.0. One would anticipate this elasticity to be positive since labour should be a substitute for salmon in the importers adjustment process (Wohlgenant, 1989). However, it is somewhat surprising that the effect is so strong. In particular it implies that other marketing costs are complementary to the main input salmon.[13]

The adjustment speed is approximately 0.85 suggesting a quite flexible demand structure. The Box-Pierce statistics indicate no autocorrelation (Q1 and Q2). A static version of the model

[12] The parameters on the price (P), the Danish wage index (Z) and the cross products between them (PZ) are all insignificant. The reason is multicollinearity, i.e., the cross product term and the price has a correlation of 0.96. If we impose a joint F-test where the null hypothesis is $\alpha_P = \alpha_Z = \alpha_{PZ} = 0$, it is clearly rejected with an F of 28.51. Hence, the combination of a high explanation power, high correlation between the variables, the F-test results and reasonable economic predictions clearly suggest that the structural demand equation is correctly specified.

[13] We have also estimated a demand model where we included the Danish export price to Germany, their most important market (reefer the discussion in footnote 10 on derived demand and our assumption of separability in output). The demand model does not change and the export price enters as a non-significant variable. Elasticities and predictions do not change substantially, we still find unit elastic demand and a positive cross price effect.

Table 2
Results demand equation (10) using 2SLS for the period 1993:1 to 1999:12. Dependent variable is quantity demanded *Q*.

	Coefficient	Standard Error
P	-1304176	1567910
Z	-249247	415831
PZ	12323.43	15852.57
Q_{t-1}	0.152***	0.082
D_8	643336***	204853
D_9	1116690***	199386
D_{10}	1293458***	209034
D_{11}	1106824***	225478
D_{12}	1618192***	219425
Trend	36839.9***	9865.56
Constant	2.68E+07	4.15E+0.7
Box-Pierce, Q1	1.051†	
Box-Pierce, Q2	1.114†	
Sargan validity of Instruments test(2)	2.63†	
Centered R^2	0.896	
N	83	

*** Significant at a 1% level, ** Significant at a 2.5% level, *Significant at a 5% level
† Chi-square statistics

Table 3
Elasticity estimates

	Elasticity	Chi-square statistics
Short run EL_{PP}	-0.840*	4.21
Short run EL_{ZZ}	1.694**	6.33
Long run EL_{PP}	-0.990*	4.05
Long run EL_{ZZ}	1.999**	6.64

*** Significant at a 1% level, ** Significant at a 2.5% level, *Significant at a 5% level failed the autocorrelation tests.[14] The Sargan test results are more dubious suggesting that the instruments used might be weak.

Turning to the supply relation (11) the results are presented in Table 4 column 2. Also here the centered R^2 is high. The individual parameters are more significant here, and the Sargan test suggests that the instruments are better in this model. The model behaves well also in terms of autocorrelation, the partial adjustment term removes autocorrelation and the Box-Pierce statistics are low. The adjustment speed is relatively low (0.55) suggesting that it takes some time to move back to the long-run equilibrium after shocks, which is as expected given the biological production process.[15] The most interesting economic result is that the mark-up parameter suggests market power but very little and not any significant market power.[16] This indicates that Norway had no market power on average over the estimated period, but also that one was not pricing bellow marginal cost – no dumping took place.

Now we re-estimate the supply relation but to account for the effects of the salmon agreement we include also $Q^{*}_{salm-agreem}$ in the equation (11'). The results are presented in Table 4 column 3. Several things are interesting to note. First the model behaves marginally worse in terms of statistical properties, *e.g.*, explanation power is decreased, the Box-Pierce statistics suggest autocorrelation (Q2) at a 5% level, and the Sargan test is weaker. The parameters measuring

[14]Both the Durbin Watson (DW) test and the Box-Pierce tests for the static version conclude autocorrelation, DW=1.55 and Q1=4.32 and Q2=4.51)

[15] The static counterpart fails both the Box-Pierce tests and the Durbin Watson test for autocorrelation (e.g the test statistics for model 1 (11) are all concluding with autocorrelation DW=0.22, Q1=63.38 and Q2=106.35).

[16] Note that in the present context, a negative parameter between -1 and 0 suggests none, or some kind of market power. A positive number implies prices bellow marginal cost and thereby dumping. In the text the latter situation is referred to as "negative" markup which implies dumping bellow marginal cost.

Table 4
Results supply relation (11) using 2SLS for the period 1993:1 to 1999:12. Dependent variable is import price *P*.

	Model 1[a] (11)	Model 2[a] (11')	Model 3[a] (11'')
W	0.271*** (0.054)	0.296*** (0.055)	0.303*** (0.053)
Q	-6.88E-08 (1.75E-07)	-4.70E-07 (3.79E-07)	-2.47E-07 (1.97E-07)
Q^*	-0.004 (0.019)	-0.033 (0.032)	
$Q^*_{salm-agreem}$		-0.067* (0.038)	-0.047** (0.023)
P_{t-1}	0.692*** (0.065)	0.667*** (0.065)	0.669*** (0.063)
Long run Q^*	-0.014 (0.05) †	-0.100 (1.00)†	
Long run $Q^*_{salm-agreem}$		-0.30 (1.91)†	-0.143* (3.38)†
Box-Pierce, Q1	2.11†	2.95†	1.81†
Box-Pierce, Q2	2.26†	3.16†	1.88†
Sargan validity of instruments test(12)	6.98*†	6.46*†	7.08*†
Centered R^2	0.844	0.833	0.844
N	83	83	83

*** Significant at a 1% level, ** Significant at a 5% level, *Significant at a 10% level
† Chi-square statistics
[a]The difference between the models is that Model 1 does not allow the salmon agreement to have changed the mark up, Model 2 allows a different markup before and after the salmon agreement and Model 3 restricts the markup before the salmon agreement to zero.

the mark-up are both suggesting some market power. They are now both larger in magnitude than what we found in the previous model, suggesting that the inclusion of a separate agreement period mark-up picks up some important markup information. Interestingly enough, we now also find both markup parameters to be more precisely estimated. The long-run estimates of the agreement period can only be rejected at a 17% level. However, even though the size of the markup parameters now are in the range of -0.30 to -0.10 they are still not significant on conventional significance levels.

Even though the estimated parameter associated with a markup in the full period is more precise now, it is still not statistically significant. However, the parameter associated with the salmon agreement period is statistically significant at a 10% level. We therefore estimate a third model where we exclude the markup variable ($Q^{*)}$ for the whole period, only allowing a markup ($Q^{*}_{salm-agreem}$) during the salmon agreement period:

(11'') $$P_t = \phi_{P,i} P_{t-i} + \beta_Q Q_t + \beta_W W_t + \lambda_{salm-agreem} Q^{*}_{salm-agreem,t} + \varepsilon_t$$

The results for this model are presented in Table 4 in column 4. This model performs better than both the two other models (11) and (11').[17] We can now reject autocorrelation on all conventional significance levels and the validity of the instruments can be accepted on a 7% level. The short-run markup parameter is significant at a 5% level suggesting a markup of 0.05. The long-run markup is three times as high; 0.14 and significant at a 7% level. Hence, to the extent that Norwegian exporters have any market power, this was obtained after the salmon agreement was imposed. The results give no support to the notion that dumping actually was taking place before the measures were implemented, as there is no evidence that the price is lower then marginal cost in any models.

[17] We have also estimated (11'') based on the demand equation including also the output price to Germany (reefer footnotes 10 and 13). The estimated markups increase with less than 5%, suggesting short and long run markups in the order of 0.049 and 0.149 respectively. The significance levels increase also marginally.

We find that after the sales organisation that coordinated Norwegian sales, there are no evidence that Norwegian salmon farmers have market power. This changes with the introduction of trade restrictions, that accordingly appear to act as a coordinating device. The indicated mark-ups are in the range of 0.05 to 0.14, which is higher numbers than found in Steen and Salvanes (1999) for France. They found markup numbers in the range of 0.03 to 0.05. However, they could not find the long-run mark-up to be significant. It is interesting to note that the markup is not higher then the duty the exporters would have to pay if they do not abide by the agreement. Hence, it seems as the salmon agreement and feed quota regime imposed on the Norwegian farmers actually has made it possible for Norway to regain, and even increase market power in the EU market.

Concluding remarks

In this paper we use the Breshnahan-Lau model to investigate market power in a trade setting. The demand schedule has been reformulated as a derived demand schedule to reflect importer's demand. The model is particular useful in a trade setting as it also allows a test of whether dumping has taken place. This is because a "negative" mark-up is associated with a situation where price is bellow marginal cost. By allowing for structural changes in the mark-up parameter, one can also test hypothesis with respect to changes in market structure over time.

Salvanes and Steen (1999) provide evidence that Norwegian farmers had market power in the short, but not in the long run until 1992, when a common sales organization was mandatory for all farmers. This organization was abolished in November 1992, and we find that in the following years, Norwegian farmers do not exploit market power. This change with the introduction of the salmon agreement and the Norwegian feed quotas. These regulations can be regarded as an effort to influence the salmon price in the EU by coordinating a limitation of supply from all Norwegian suppliers. With a share of the farmed salmon production of about 50% at the time, this should make Norway a dominant player when the actions of the individual farmers are coordinated.

The results indicate no evidence of Norwegian farmers exploiting market power before the salmon agreement was implemented. Moreover, the results indicate that no dumping was taking place, and accordingly suggest that the trade restrictions that were put into place are primarily protectionist devices. The introduction of the salmon agreement and the feed quotas led Norwegian farmers to exploit market power. Hence, the agreement can be regarded as successful in supporting the salmon price in the EU, but with the cost of lower consumer surplus in the EU. In particular this consumer surplus loss has been transferred to the Norwegian industry as economic rent. The EU salmon farmers have also gained in terms of increased producer surplus, but as long as Norway has such a large market share it is very likely that the net gain to EU in terms of welfare is negative.

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