When anti-dumping measures lead to increased market power; A case study of the European Salmon Market

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Abstract

In this paper we apply the Bresnahan-Lau (1982) model to test for market power in the European distribution of salmon. Utilising data at the import level, derived demand equations are specified rather then consumer demand. Earlier studies using this approach (Steen and Salvanes, 1999) found some evidence of market power. 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 apply a newer dataset to test whether the agreement resulted in an increase in the Norwegian market power. The results suggest that Norway regained market power and even increased it due to this salmon agreement. 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. This increase in market power is not welfare improving to the EU consumers and should therefore be traded off against the benefit of protecting EU salmon producers.

Keywords: Antidumping, market power, salmon markets
J.E.L. codes: L13, C32, C22

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 coordinating device that force the industry in a country to exploit market power when it is found guilty in a dumping case. In particular, 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. To our knowledge, no studies using the newer structural empirical approach (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 fresh salmon following trade measures from the European Commission. 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. However, in 1996 a scheme of feed quotas was introduced in following trade tensions with the EU to support EU policies to stabilise salmon prices, and 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. In this paper we use data up to 2000 to analyse whether the salmon agreement and the Norwegian feeding program resulted in Norway exercising market power. 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. Hence, the imposed antitrust measures work as a possible exogenous structural break in the market structure allowing us to implement parametric tests for shifts in market power in the Bresnahan-Lau model.

Salmon has been the most successful modern aquaculture industry, and has experienced rapid growth during the last two decades as production has increased from virtually nothing in 1980 to about 1.3 million tonnes in 2000. However, there have been a number of trade conflicts as the rapid growth has caused a major decline in prices. There have therefore also been several attempts to stabilise prices, of which the salmon agreement and the Norwegian feed quotas can be regarded as one.[1] However, this also immediately raise the issue of market power, as one needs market power at least in the short run for such 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 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

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[1] Norway as well as the second largest producer of salmon, Chile, faces anti-dumping duties in the US after being found guilty in dumping (Asche, 2001).

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.

The results indicate no evidence of Norwegian farmers exploiting market power before the agreement was in place, but conclude that the salmon agreement led Norwegian exporters to exploit market power. 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 the long run 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. 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, a part of this loss of consumer surplus has been transferred to the Norwegian industry outside EU 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 (higher then 50%) and the Scottish farmers represent less than 15% of global production and 25% of the supplies to the EU it is very likely that the net gain to EU in terms of welfare is negative.

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 over one million tonnes in 1999, 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, hence 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).

[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.

It is also worthwhile noting that farmed salmon is produced in large quantities in only a few countries. With their 1999-share in parenthesis, Norway (46%), Chile (20%), the UK (14%) and Canada (8%) make up about 90% of the total quantity produced. Given that Canada and 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). The main target has been Norway, not surprisingly given its dominant share of production, but recently Chilean producers have also been found guilty of dumping in the US, and face charges in the EU.

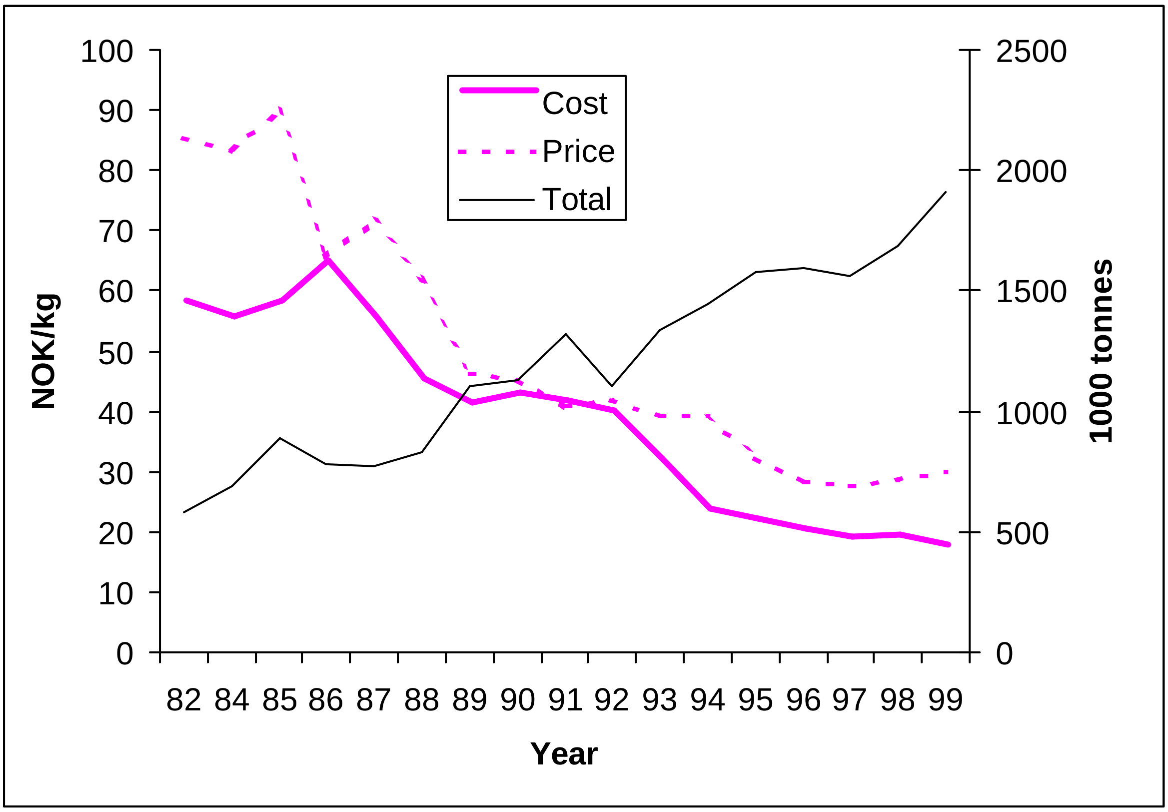

Figure 1. Global supply of salmon with real Norwegian export price and production cost, 1982-1999

In 1997 Norway and EU entered a salmon agreement after it was clear that the European Commission had found evidence that indicated a dumping margin for Norwegian farmers and exporters. 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 exports salmon to the EU does so under this agreement. As a prelude to this agreement, the Norwegian government created 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 support the EU in stabilising salmon prices in Europe. This feeding quota restricted the Norwegian production from 1997, and can be regarded as limitation of supply from all Norwegian farmers coordinated by the government. The salmon agreement regime is still in operation.

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

The Bresnahan Lau model

The demand side may be described by (Bresnahan,1982 and Lau, 1982);[4]

$$(1) \qquad Q = D(P, Z; a) + e,$$

where Q is quantity, P is price and Z is a vector of exogenous variables affecting demand.

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

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. a is the vector of parameters to be estimated and e is the error term.

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

(2) $P = c(Q, W; b) + h$,

where W are exogenous variables on the supply side, e.g. factor prices, b the supply function parameters, and h 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;

(2') $P = c(Q, W; b) - l \cdot h(Q, Z; a) + h$,

where $P + h(\cdot)$ is marginal revenue, and $P + l \cdot h(\cdot)$ is marginal revenue as perceived by the firm. Hence, l is a new parameter that may be interpreted as a markup parameter measuring the degree of market power. Under perfect competition, $l = 0$ and price equals marginal cost. When $l = 1$ we face a perfect cartel, and when $0 < l < 1$ various oligopoly regimes apply. Alternatively one can say that l is the percentage of monopoly marginal revenue perceived.

The general empirical problem in all market structure studies is how to identify l. 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; $Q = a_0 + a_P P + a_Z Z + a_{PZ} PZ + e$, and the marginal cost function is; $MC = b_Q Q + b_W W$. The supply relation is now;

$$(3) \qquad P = b_Q Q + b_W W - l\left[\frac{Q}{a_P + a_{PZ} Z}\right] + h\ ,$$

since $MR = P + [Q/(a_P + a_{PZ} Z)]$. By treating a_P and a_{PZ} as known (by first estimating the demand equation), l is now identified. To see this, write $Q^* = -Q/(a_P + a_{PZ} Z)$. There are two included endogenous variables, Q and Q^* and there are two excluded exogenous variables *Z* and *PZ* in (3). Hence, l 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.[5]

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)

[5] 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), Advertising; Jung and Seldon (1995), lumber; Bernstein (1994), Coconut oil; Buschena and Perloff (1991).

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 problem.[6] 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

(4) $$Q_t = a_0 + \sum_{i=1}^{k-1} g_{Q,i} Q_{t-i} + a_P P_t + a_Z Z_t + a_{PZ} PZ_t$$

where the long run parameters are given as:

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

e.g., the parameter q_P measures the stationary long-run impact of P_t on Q_t. 1-g^* is usually denoted as the adjustment speed and measures the impact on Q_t of being away from the long-

6 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.

run target; that is, $1-\sum_{i=1}^{k-1} g_{Qi}^{*}$ measures how fast firms can correct the errors of past decisions.

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

(6) $$P_t = \sum_{i=1}^{k-1} f_{P,i} P_{t-i} + b_Q Q_t + b_W W_t + l Q_t^{*} ,$$

where

(7) $$Q_t^{*} = Q_t \big/ (q_P + q_{PZ} Z_t)$$

and

(8) $$\Lambda = l \Big/ 1-\sum_{i=1}^{k-1} f_{Pi} , b_Q^{*} = b_Q \Big/ 1-\sum_{i=1}^{k-1} f_{Pi} , b_W^{*} = b_W \Big/ 1-\sum_{i=1}^{k-1} f_{Pi}$$

The PA -formulation provides both a short-run measure of l : l 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.

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.[7] Costs are represented by farm gate prices on fresh

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[7] 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 maximisers or alternatively output quantity if the importers were assumed to be a cost minimisers. 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 as 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.

salmon. All prices are measured 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:

$$(10) \qquad Q_t = a_0 + \sum_{i=8}^{12} D_{t,i} + g_{Q1} Q_{t-1} + a_P P_t + a_Z Z_t + a_{PZ} P_t Z_t + y\, trend + h_t$$

and the supply relation from (6) is now:

$$(11) \qquad P_t = f_{P,i} P_{t-i} + b_Q Q_t + b_W W_t + l\, Q_t^* + e_t$$

where W is farm gate price in Norway, and $Q_t^* = Q_t / \left(q_P + q_{PZ} Z_{t\,t} \right)$. 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’) $P_t = f_{P,i} P_{t-i} + b_Q Q_t + b_W W_t + l Q_t^* + l_{salm-agreem} Q_{salm-agreem,t}^* + e_t$

Where $Q_{salm-agreem,t}^* = (Q_t / (q_P + q_{PZ} Z_t)) \cdot D_{salm-agreem}$. 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.[8] 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 ($D_{salm\text{-}agreem}$). A potential simultaneity problem is present because for farmed fish, farmers/exporters have an elastic supply curve (Steen, Asche and Salvanes, 1997). The instruments *W*, and $D_{salm\text{-}agreem}$ 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*.[9] 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 used since Germany is the most important market for processed (smoked) Danish salmon.

Empirical results

The demand function results are presented in Table 1. The centered R^2 is nearly 0.90.[10] 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

[8] 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.

[9] 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.

[10] 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, e.g., 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 that $a_P = a_Z = a_{PZ} = 0$ this 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.

Table 1
Results demand equation (10) using 2SLS for the period 1993:1 to 1999:12

	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
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†
Q1	1.051	
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

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 typical elasticities in the order of -2.0 and above, 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.[11]

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 failed the autocorrelation tests.[12] 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 2 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

[11] 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 7 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.

[12] 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)

the biological production process.[13] The most interesting economic result is that the mark-up parameter has the right sign but is very small and not significant. This indicates that Norway had no market power on average over the estimated period.

Table 2
Results supply relation (11) using 2SLS for the period 1993:1 to 1999:12

	Model 1 (11)	Model 2 (11')	Model 3 (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)†
Q1	2.11	2.95	1.81
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

[13] 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).

Now we re-estimate the supply relation but include also $Q^{*}_{salm-agreem}$ in the equation (11') to account for the effects of the salmon agreement. The results are presented in Table 2 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 the mark-up are both negative and in the expected interval. 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 pick 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'') $$P_t = f_{P,i} P_{t-i} + b_Q Q_t + b_W W_t + l_{salm-agreem} Q^{*}_{salm-agreem,t} + e_t$$

The results for this model are presented in Table 2 in column 4. This model performs better than both the two other models (11) and (11').[14] 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. All the time this regulation is still in place it is tempting to conclude that Norway has some market power today as well.

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 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

The salmon agreement and the Norwegian feed quota 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. To investigate whether this was successful we estimated a dynamic Bresnahan-Lau model. We modelled the demand as derived demand rather then consumer demand to

[14] We have also estimated (11'') based on the demand equation including also the output price to Germany (reefer footnotes 7 and 11). 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.

reflect the fact that the data is at the import level. To account for the possible effect of the salmon agreement, a separate variable was constructed allowing for a structural change in the markup when the agreement was implemented.

The results indicate no evidence of Norwegian farmers exploiting market power before the salmon agreement was implemented, but indicate that 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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