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# Relative Impact of the Norway-EU Salmon Agreement: A Midterm Assessment

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**Relative Impact of the Norway-EU Salmon Agreement:  
A Midterm Assessment\***

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## **Abstract**

*An agreement between Norway and the European Commission specifies an increase in the export tax on Norwegian salmon entering EU markets from 0.75% to 3.00% effective 1 July 1997. Further, Norway's exports are subject to a price floor and quantity ceiling, neither of which were binding over the evaluation period. Since the tax's proceeds are to be used by Norway to fund generic marketing of Atlantic salmon, it is possible that the agreement is win-win, i.e., benefits United Kingdom and Norwegian producers alike. To test this, we use an equilibrium displacement model to estimate the agreement's effects on prices, trade flows, and producer welfare. Results based on data through 1999 suggest the agreement is indeed win-win, but that currency realignments and feed quota policy can easily neutralize or obscure the effects.*

**Key words:** equilibrium displacement modeling, export tax, generic advertising, trade policy

## **Relative Impact of the Norway-EU Salmon Agreement: A Midterm Assessment**

“Exchange rate movements can easily swamp or obscure the desired price, trade, or production effects of any specific agricultural commodity policy.”

Houck, 1986, p. 158

### **1. Introduction**

With a 45% market share in 1999, Norway is the world’s leading producer of farmed salmon. Because 97% of Norway’s production is exported, and farmed salmon now constitutes the major share of salmon consumed in the world, Norway is the prime target for countries wishing to protect their domestic salmon sectors via trade restrictions. Indeed, both the United States and the European Union have been successful in this regard (Asche 1997, 2001; see also Steen and Salvanes 1999). At issue here is not the merits of these trade sanctions, but rather their economic impacts. In particular, building on Kinnucan and Myrland’s (2000) work, we specify an equilibrium displacement model that takes into account the key provisions of the 1997 Norway-EU salmon agreement (hereafter “SA”). SA is unique in that, unlike other trade-restraining policies, it seeks to strengthen market demand via advertising. Specifically, SA specifies an increase in the *ad valorem* tax on Norwegian salmon entering EU markets from 0.75% to 3.00%, with the proceeds to be used by Norway for generic marketing of Atlantic salmon (Bull and Brittan 1997). Accordingly, depending on the magnitude of the advertising-induced demand shifts, it is possible for SA to benefit Norwegian producers, even though its chief aim is to protect United Kingdom producers.

The purpose of this research is to determine SA’s efficacy. In particular, to what extent did SA increase the EU price, and what was the impact on Norwegian producers? Because the analysis is based on data through 1999, the assessment refers to “midterm” impacts, i.e., impacts halfway into SA’s five-year life. (Unless re-authorized, SA will expire 30 June 2002.) Such an assessment is useful to policy makers in that it provides an “early read” on whether SA is having the intended consequences. Also, it is useful to managers and producers in that it tells whether SA-funded promotional activities are efficient in the sense that benefits exceed costs. In addition to the tax/advertising provision, SA also specifies a price floor and quantity ceiling on Norwegian salmon entering EU markets. Although these provisions were non-binding over the evaluation period, simulations are nonetheless performed to indicate how the price and quantity controls might affect inferences about policy impact.

SA is not the only factor affecting salmon markets over the period in question. For example, the feed quota that constrains Norway’s salmon production was relaxed 12% between 1997 and 1999. By increasing the supply of salmon, this would tend to work at cross-purposes to SA from the UK producers’ perspective. In addition, currency realignments and changes in shipping costs have affected international terms of trade. As Houck notes, exchange rates in particular can swamp or obscure the effects of sector-specific policies. Accordingly, a secondary objective is to determine the impacts of these external factors so that SA’s effect can be placed in perspective. This objective is important because it provides the basis for a more realistic assessment of the extent to which the policy instruments *per se* can affect the market.

The analysis proceeds by first specifying an equilibrium displacement model (EDM) of the Norwegian salmon sector. An advantage of the EDM approach to policy analysis is its ability to handle a wide array of variables, including external factors such as shipping costs and

exchange rates, in a simple yet theoretically consistent fashion (Piggott 1992; see also Davis and Espinoza 1998). After solving the model for the reduced-form elasticities, SA's relative impact on prices, quantities and trade flows are assessed, the feed quota is analyzed, and benefit-cost analysis is performed to determine the tax and advertising's net effect on Norwegian producer welfare. The paper concludes with a summary of key findings.

## 2. Structural Model

The basic model that describes initial equilibrium in the Norwegian salmon sector is as follows:

$$\begin{aligned}
 (1) \quad & q_N = D(p_N, A_N) \\
 (2) - (4) \quad & q_i = D(p_i, A_i, CZ_i) \quad i = E, J, R \\
 (5) - (7) \quad & p_i = f(p_i, Z_i, C_i, T_i) \quad i = E, J, R \\
 (8) \quad & p_N = g(p) \\
 (9) \quad & x = S(p, ) \\
 (10) \quad & x = q_N + q_E + q_J + q_R
 \end{aligned}$$

Equations (1) - (10) represent a vertical market (farm to wholesale) with horizontal separation on the demand side (see table 1 for variable definitions). A horizontal separation is specified to reflect the policy intervention in the EU market, and the potential for market-specific responses to promotion, exchange rates, and international price transmission. Demand interrelationships, although not specified explicitly, are taken into account by using total (rather than partial) demand elasticities in the reduced form to be specified later.

The promotion variables in the export demand equations (2) - (4) are multiplied by exchange-rate variables to reflect the fact that appreciation (depreciation) of the Norwegian kroner makes export promotion less (more) expensive. The international price-transmission equations (5) - (7) and the domestic price-transmission equation (8) are specified under the twin assumptions that prices are determined in a free market (Bredahl, Meyers, and Collins, 1979; Dutton and Grennes, 1988; Gardner, 1975), and that salmon markets are integrated, i.e., the law of one price (LOP) holds (Asche, Bremnes, and Wessells, 1999 ; see also Asche, Salvanes, and Steen, 1997). The market-clearing condition (10) is based on the implicit assumption that the aggregate farm-wholesale production function exhibits fixed proportions, i.e., the dressing percentage is a fixed constant. The model is static in the sense that stocks, which are assumed to represent working or "pipeline" inventories, are ignored.

The model contains 10 endogenous variables ( $q_N, q_E, q_J, q_R, x, p_N, p_E, p_J, p_R,$  and  $p$ ) and 14 exogenous variables. Four of the exogenous variables are under industry control ( $A_N, A_E, A_J,$  and  $A_R$ ), six are controlled by forces external to the salmon industry ( $C_E, C_J, C_R, Z_E, Z_J,$  and  $Z_R$ ), and four are under government control ( $T_E, T_J, T_R,$  and  $\cdot$ ). Two other policy variables specified in SA, namely the price floor ( $_{MIN}$ ) and export ceilings ( $_{MAX}$ ), are not specified since they were inoperative over the evaluation period (table 1).

The model can be expressed in terms of percentage changes by totally differentiating the system to yield:

$$\begin{aligned}
 (1') \quad & q_N^* = Z_N p_N^* + \$_N A_N^* \\
 (2') - (4') \quad & q_i^* = Z_i p_i^* + \$_i (A_i^* + Z_i^*) \quad i = E, J, R \\
 (5') - (7') \quad & p_i^* = R_i p_N^* + \gamma_i Z_i^* + \ast_i C_i^* + J_i T_i^* \quad i = E, J, R \\
 (8') \quad & p_N^* = \cdot p^* \\
 (9') \quad & x^* = \cdot r_{x,p} p^* + \cdot x_{x,F}^* \\
 (10') \quad & x^* = \epsilon_N q_N^* + \epsilon_E q_E^* + \epsilon_J q_J^* + \epsilon_R q_R^*
 \end{aligned}$$

where the asterisked variables refer to relative changes (e.g.,  $q_N^* = dq_N/q_N$ ), and the parameters are as defined in table 2. Equations (1') - (10') belong to the class of models called Equilibrium Displacement Models (EDMs). EDMs' strengths and weaknesses for policy analysis are described by Piggott (1992) (see also Davis and Espinoza, 1998). Their main virtue is the ease with which reduced-form elasticities can be computed. To obtain these, the model is first expressed in matrix notation as follows:

$$(11) \quad \mathbf{A} \mathbf{Y} = \mathbf{B} \mathbf{Z},$$

where  $\mathbf{A}$  is a 10 x 10 matrix of parameters corresponding to the model's endogenous variables,  $\mathbf{Y}$  is a 10 x 1 vector of endogenous variables,  $\mathbf{B}$  is a 10 x 14 matrix of parameters corresponding to the model's exogenous variables, and  $\mathbf{Z}$  is a 14 x 1 vector of exogenous variables.

Premultiplying (11) by  $\mathbf{A}^{-1}$ 's inverse yields:

$$(12) \quad \mathbf{Y} = \mathbf{C} \mathbf{Z}$$

where  $\mathbf{C} = \mathbf{A}^{-1} \mathbf{B}$  is a 10 x 14 matrix containing the model's full set of reduced-form coefficients or elasticities. To compute  $\mathbf{C}$  the model's parameters have to be assigned numerical values.

### 3. Parameterization

Numerical values for the parameters are listed in table 2. The demand, advertising, and domestic price transmission elasticities correspond to the values used in Kinnucan and Myrland's (2000) analysis and thus attention will be restricted to the remaining parameters.

#### *International Price Transmission, Exchange Rate, and Shipping-Cost Elasticities*

KM's analysis did not consider exchange rates or shipping costs. As such, the international price-transmission elasticities were implicitly assumed to be equal to one. As noted by Bredahl, Meyers and Collins (1979) (see also Collins, 1980), international price-transmission elasticities are generally less than one when transportation costs are nonzero.

Accordingly, this study relaxes the assumption of unitary transmission elasticities by positing a simple markup rule. Specifically, the foreign price is set equal to the domestic price plus the per-unit shipping cost, adjusted for the relevant bilateral exchange rate and export tax. As shown in appendix A, this rule implies that price-transmission and exchange-rate elasticities are equal to one another, and to one minus the shipping-cost elasticity, i.e.,

$$(13) \quad R_i = \gamma_i = (1 - \alpha_i) \quad (i = E, J, R).$$

Since the shipping-cost elasticities  $\alpha_i = (1 + T_i)C_i/p_i$  are less than one in this study, the same is true of the price-transmission elasticities  $R_i$ . Thus, restriction (13) is consistent with Bredahl, Meyers, and Collin's (1979) analysis.

The markup rule implies the shipping-cost elasticity for the EU is  $\alpha_E = 0.05$ , since shipping costs between 1997 and 1999 accounted for approximately 5% of the EU price (see table 1), and the pre-SA export tax is minuscule ( $T_E = 0.0075$ ). Accordingly, the price-transmission and exchange-rate elasticities for the EU are set equal to 0.95. For Japan, where shipping costs are much higher  $\alpha_J = 0.16$ , which implies  $R_J = \gamma_J = 0.84$ . For the ROW, where U.S. data points are used as a proxy, the elasticities are  $\alpha_R = 0.08$  and  $R_R = \gamma_R = 0.92$ .

The export-tax transmission elasticities are set to  $J_i = 0.0074$  ( $i = E, J, R$ ). These elasticities are computed using the formula  $J_i = T_i/(1 + T_i)$  derived in appendix A, where  $T_i$  are the tax rates in force prior to SA.  $J_E = 0.0074$  indicates the percentage increase in the EU price per 1% increase in the EU tax rate, *holding constant the domestic price*. Thus, the 300% tax hike called for in SA would be expected to increase the EU price by 2.2%, *provided the domestic*

*price does not change.* In reality, the domestic price is lowered by an increase in the export tax; hence, the actual change in the EU price would be less than 2.2%.

#### *Farm Supply and Feed Quota Elasticities*

In KM's study the farm supply elasticity was set to 1.54, Steen, Asche, and Salvanes's (1997) estimate of this parameter's long-run value. Since SAS's study is based on data that terminate in 1995, prior to the feed quota, the supply elasticity is properly interpreted as an upper-bound estimate. In particular, as shown in appendix B, a feed quota reduces the supply elasticity. The extent of the reduction depends on the supply elasticities for feed and non-feed inputs ( $\epsilon_F$  and  $\epsilon_K$ , respectively), but also on the feed cost share ( $S_F$ ), and the elasticity of substitution between feed and non-feed inputs ( $F$ ). For example, setting  $\epsilon_K = 1$  and  $S_F = 0.46$  our "best-guess" estimates of long-run values, and simulating the elasticity expressions over a range of plausible values for  $\epsilon_F$  and  $F$  (see appendix table B.1) yielded an average "without quota" elasticity of 1.58 and an average "with quota" elasticity of 0.39, a 75% reduction.

Accordingly, we set the farm supply elasticity to  $\epsilon_{x,p} = 0.39$ , which is 25% of SAS's estimate. However, to assess the sensitivity of results to the supply elasticity, and to provide an estimate of the "short-run" (one year or less) responses to the exogenous variables, we ran an additional simulation with  $\epsilon_{x,p} = 0$ .

As for the "feed-quota elasticity," i.e., the elasticity that indicates the horizontal shift in the farm supply curve per 1% increase in the quota, no empirical estimates exist for this parameter. However, as shown in Appendix B, this parameter has a theoretical upper limit of 1, and a practical lower limit of 0.5. Accordingly, we set the feed-quota elasticity to  $\epsilon_{x,F} = 0.61$ , the value that corresponds to the quota-constrained farm supply elasticity (see appendix table B.1).

#### **4. Reduced-Form Elasticities**

Reduced-form elasticities based on the foregoing parameter values are given in table 3. Attention is restricted to farm price and farm quantity in Norway and EU price and Norway's exports to the EU, the four SA-germane endogenous variables. Unless indicated otherwise, discussion will focus on long-run effects.

All elasticities have the expected signs. For example,  $q_E^*/T_E^* < 0$  and  $p_E^*/T_E^* > 0$ , which means an increase in the EU export tax decreases Norway's exports to the EU and raises the EU price, a major policy goal from the EU's perspective. Similarly,  $p^*/A_i^* > 0$  and  $x^*/A_i^* > 0$  for  $i = N, E, J, R$ , which means an increase in advertising in any market increases farm revenue, an intended result from Norway's perspective. An increase in shipping cost to the EU has the same effect as an increase in the export tax, i.e.,  $q_E^*/C_E^* < 0$  and  $p_E^*/C_E^* > 0$ , as might be expected since an increase in shipping cost makes Norwegian salmon more expensive to EU consumers.

The three most important variables affecting Norway's exports to the EU are: euro/kroner exchange rate ( $q_E^*/Z_E^* = -0.78$ ), feed quota ( $q_E^*/Q^* = 0.50$ ), and US\$/kroner exchange rate ( $q_E^*/Z_R^* = 0.22$ ). That  $q_E^*/Z_E^*$  and  $q_E^*/Z_R^*$  have opposite signs suggests a simultaneous strengthening/weakening of the kroner against the euro and the US dollar has offsetting effects on EU exports. By way of comparison, the largest advertising elasticity is  $q_E^*/A_E^* = 0.018$ . This implies, for example, that an isolated 1% increase in the euro/kroner exchange rate is sufficient to neutralize a 44% increase in EU advertising expenditure. And this is true even after



taking into account the induced advertising expenditure associated with kroner strengthening. (Recall advertising and exchange rate enter (2) - (4) multiplicatively.) The reduced-form elasticity  $q_E^*/A_E^* = 0.018$  is less than half the structural elasticity  $\$E = 0.040$ . This highlights the importance of taking into account induced price effects when modeling advertising impact.

## 5. Relative Impacts

Elasticity estimates alone can be misleading as an indicator of relative impact. In particular, as Duffy notes (1989, p. 95), one needs to take into account the variables' changes. Accordingly, we computed the actual percentage changes in the exogenous variables between 1997 and 1999 as indicated in table 4. These changes were multiplied by table 3's *long-run* reduced-form elasticities to determine relative impact.

Owing to the large increases in advertising expenditure, which range from 92% for Japan to 282% for ROW, advertising has the largest impact on price of all the variables studied (table 4). In particular, advertising's overall impact on farm price was 6.1%, compared to 5.7% for exchange rates, -4.7% for feed quota, -1.8% for export tax, and -0.6% for shipping costs. As for EU price, advertising's overall impact was 4.2%, compared to -3.2% for feed quota, 1.0% for export tax, -0.22% for shipping costs, 0.15% for exchange rates. (The exchange rates' modest net effect on EU price in the face of an overall weakening in the kroner is due to the aforementioned offsetting effects -- compare table 3's values for  $p_E^*/Z_i^*$ .) Thus, despite its tiny elasticities, advertising's impact was important. In fact, thanks largely to advertising, the net price effect of the observed changes in the exogenous variables was positive, i.e., farm price increased by 4.7% and the EU price increased by 1.9%.

Turning to quantity impacts, feed quota has the largest impact, followed by advertising. Specifically, feed quota's impact on farm quantity was 5.7%, compared to 2.4% for advertising, 2.2% for exchange rates, -0.7% for export tax, and -0.2% for shipping costs. Adding up these impacts yields an overall increase in farm quantity of 9.4%. As for exports, quota relaxation was responsible for a 6.2% increase in Norway's exports to the EU, followed by advertising, which increased exports by 2.1%. The export tax, exchange rates, and shipping costs have smaller impacts, -1.9%, -0.45%, and 0.42% respectively. The overall net effect was 6.4%. Thus, despite the elevated tax, Norway was able to increase its exports to the EU, thanks largely to quota relaxation, but also to promotion intensification, which accounts for nearly one-third of the measured export enhancement.

## 6. Benefit-Cost Analysis

A key issue from the Norwegian producer perspective is whether the advertising increased demand sufficiently to compensate for the negative effects of the export tax. To determine this, we measured producer welfare effects using the formulas:

$$(14a) \quad ) PS_T = [p^*/T_E^*] T_E^* v (1 + \frac{1}{2} [x^*/T_E^*] T_E^*)$$

$$(14b) \quad ) PS_{Ai} = [p^*/A_i^*] A_i^* v (1 + \frac{1}{2} [x^*/A_i^*] A_i^*) \quad i = E, J, R$$

where )  $PS_T$  is the change in producer surplus due to the increased export tax, )  $PS_{Ai}$  is the change in producer surplus due to increased advertising in the  $i$ th market, and  $v = p \times x$  is industry revenue at the farm level. Equations (14a) and (14b) are approximation formulas. They are based on the assumption that demand curves shift in a parallel fashion, which may not be the case. However, if equilibrium displacements are small (say 10% or less), as is the case in this study, (14) provides a good approximation to the true welfare changes even if shifts are not

parallel (see Alston, Norton, and Pardey (1995) and references cited therein).

To apply (14) we set  $v = 22,001$  million kroner, the farm value of salmon over the 2.5 year study period (table 1). (This was computed by adding 50% of 1997 farm revenue to the cumulative farm revenue for 1998 and 1999.) The bracketed terms in (14) are set equal to the corresponding reduced-form elasticities given in table 3.  $T_E^*$  in (14a) is set to 3.0 since SA increased  $T_E$  by 300%. The correct values for  $A_i^*$  in (14b) are less clear. In particular, the advertising budget is enlarged by an increase in the tax rate, but also by an increase in export value. As shown in table 4, a portion of the increase in export value is due to factors unrelated to SA. Thus, to avoid overstating the SA effect it is necessary to separate the advertising expenditure increase due to SA from the expenditure increase due to autonomous changes in export value.

For this purpose, consider the advertising budget identity:

$$A = T_E p q_E + T_J p q_J + T_R p q_R.$$

Totally differentiating this expression, holding  $T_J$  and  $T_R$  constant (since these variables did not change over the evaluation period), yields:

$$dA = p(q_E dT_E + T_E dq_E + T_J dq_J + T_R dq_R) + (T_E q_E + T_J q_J + T_R q_R)dp.$$

Converting the above expression to percentage changes yields:

$$(15) \quad A^* = T_E (T_E^* + q_E^*) + T_J q_J^* + T_R q_R^* + p^*$$

where  $T_i = T_i q_i p/A$  is the portion of the advertising budget that comes from the  $i$ th export market. (Domestic value is not taxed.) Based on 1997 data points (see table 1):  $T_E = 0.68$ ,  $T_J = 0.08$ , and  $T_R = 0.24$ . Between 1997 and 1999 the values for the remaining variables are:  $T_E^* = 300\%$ ,  $q_E^* = 36\%$ ,  $q_J^* = 117\%$ ,  $q_R^* = -9\%$ , and  $p^* = 36\%$ .

Substituting these values into (15) yields  $A^* = 269\%$ , which is the budget growth due to changes in export value and the export tax. Budget growth due strictly to the tax change is  $A^* = T_E T_E^* = 0.68 (300\%) = 204\%$ . Thus, about three quarters of the budget growth ( $204/269 = 0.76$ ) is due strictly to the higher export tax. However, this understates SA's effect, since a portion of the value growth is due to the added advertising made possible by the tax increase. Accordingly, in assigning values to  $A_i^*$  in (14b), we entertain two scenarios. The first scenario posits that 90% of the observed advertising increase (as given in table 4) is due to SA; the second scenario posits that 76% of the increase is due to SA. Scenario 1 represents our "best-guess" estimate of the extent to which the tax increase enlarged the advertising budget when induced value effects are taken into account. Since scenario 2 ignores induced value effects, it may be interpreted as a lower-bound estimate of actual impact.

Results based on scenario 1 indicate that the tax increase caused an initial (short-term) reduction on Norwegian producer surplus equal to 527 million kroner (table 5). However, this loss is more than compensated for by an increase in producer surplus associated with the increased advertising equal to 1,582 million kroner, for a net gain of 1,056 million. Dividing the gross gain of 1,582 million by the gross loss of 527 million yields a Benefit Cost Ratio of 3.00:1. Thus, benefits exceed costs by a substantial margin in the short run.

In the long run advertising rents dissipate due to supply response (Kinnucan, Nelson, and Xiao, 1995). That is, salmon producers respond to higher profits by increasing stocking densities, intensifying feeding regimes, or both. When the extra production enters the market, prices decline. In the present case, the added production causes gross rents to decline to 1,207 million kroner. However, there is an offsetting effect on the cost side. In particular, a larger portion of the tax is shifted to EU consumers as farm supply becomes more elastic. As a

consequence, producer loss due to the export tax decreases from 527 million to 398 million kroner. The upshot is that costs decline about as rapidly as benefits. Thus, the BCR remains roughly constant at 3.03:1. Dividing the long-run net gain (809 million) by farm revenue (22,001 million) yields 0.048. This implies that SA enhanced net Norwegian producer surplus in an amount equal to 4.8% of farm revenue.

Turning to scenario 2, returns are attenuated but the basic result remains the same (table 5). In particular, the long-run BCR is reduced to 2.56:1, and the net gain as a percent of farm revenue is reduced to 3.7%. Since these estimates are conservative, it appears safe to conclude that SA has been remunerative from the Norwegian producer perspective.

## 7. Concluding Comments

Our midterm assessment suggests the Norway-EU salmon agreement is working as intended. Specifically, UK salmon producers have benefitted in that the export tax and advertising combined to increase the EU price by 5.2%. The 5.2% price enhancement is split between a 4.2% advertising effect and a 1.0% tax effect, which underscores the importance of the advertising scheme from the UK producers' perspective. Stated differently, if the agreement had relied solely on the export tax to assist UK producers, it would have been relatively ineffectual.

As for Norwegian impacts, salmon producers were net beneficiaries in that the advertising's effect on farm price (6.1%) more than offset the tax effect (-1.8%). As a consequence, the welfare effects were favorable. In particular, net producer surplus increased between 621 and 809 million kroner, which is equivalent to between 3.7% and 4.8% of farm revenue. Benefit-cost ratios are between 2.56:1 and 3.00:1. This suggests that permitting the export tax to revert to its original level would not be in Norwegian producers' interest unless the opportunity cost of advertising funds exceeds 156%.

Overall, market prices are much more sensitive to exchange rates than to the advertising and export tax. Currency realignments, therefore, can easily swamp or obscure advertising and tax effects, as Houck suggests. In addition, feed quota has a more pronounced effect than either advertising or the export tax. Thus, care must be exercised in adjusting the feed quota, as it could undo the effects of the agreement, especially from the UK producers' perspective.<sup>5</sup> Clearly, a simple comparison of prices and trade flows before and after the agreement does not provide an adequate basis for assessing policy effectiveness. What is needed is a model that holds constant extraneous factors so that the advertising and tax effects can be isolated.

This study advances such a model. Still, caveats are necessary in that results are conditional on model assumptions, and on the accuracy of parameter values. International price transmission and exchange-rate elasticities are based on a simple markup rule that assumes prices are determined in a free market. In addition, we assume that markets are equally responsive to promotion. Both assumptions need to be tested. In the meantime, the fact that we used conservative estimates of promotion response, i.e., the advertising elasticities are below the modal values in the literature, suggests that the advertising and welfare effects are more likely to be understated than overstated.

**Table 1. Variable Definitions and Values, Norway's Salmon Industry, 1997-99**

Item	Definition	Value		
		1997	1998	1999
x	Norway's production of salmon, 1,000 MT (round weight)	316	343	412

p	Farm price, NOK/kg.	18.74	25.47	25.41
	Feed quota, 1,000 MT	460	481	517
q <sub>N</sub>	Norway's domestic consumption, 1000 MT (r.w.)	14	15	16
q <sub>E</sub>	Norway's exports to European Union, 1,000 MT (r.w.)	204	252	278
q <sub>J</sub>	Norway's exports to Japan, 1,000 MT (r.w.)	23	29	50
q <sub>R</sub>	Norway's exports to Rest Of World, 1,000 MT (r.w.)	75	46	68
MAX	Ceiling on Norway's exports to EU, 1000 MT (r.w.)	244	269	295
p <sub>N</sub>	Wholesale price in Norway, NOK/kg. f. o. b.	26.56	28.01	27.91
p <sub>E</sub>	Wholesale price in EU, ECU/kg. c. i. f.	3.59	3.76	3.73
p <sub>J</sub>	Wholesale price in Japan, Yen/kg. c. i. f.	786.7	801.7	666.5
p <sub>R</sub>	Wholesale price in US (ROW proxy), US\$/kg. c. i. f.	4.31	4.11	4.38
MIN	Floor price for Norwegian salmon in EU, ECU/kg. c.i.f.	3.25	3.25	3.25
T <sub>E</sub>	Export levy on EU-destined salmon	0.0075 <sup>a</sup>	0.0300	0.0300
T <sub>J</sub> , T <sub>R</sub>	Export levy on Japan- and ROW-destined salmon	0.0075	0.0075	0.0075
A <sub>N</sub>	Norway's advertising in Norway, NOK mil.	1.0	0.3	3.7
A <sub>E</sub>	Norway's advertising in EU, NOK mil.	32.6	87.0	115.5
A <sub>J</sub>	Norway's advertising in Japan, NOK mil.	8.8	18.8	16.9
A <sub>R</sub>	Norway's advertising in ROW, NOK, mil.	6.2	13.8	23.7
Z <sub>E</sub>	Norway-EU exchange rate, ECU/NOK	0.125	0.118	0.120
Z <sub>J</sub>	Norway-Japan exchange rate, Yen/NOK	17.2	17.3	14.6
Z <sub>R</sub>	Norway-US exchange rate, US\$/NOK	0.142	0.132	0.128
C <sub>E</sub>	Shipping costs to EU, ECU/kg.	0.184	0.181	0.192
C <sub>J</sub>	Shipping costs to Japan, Yen/kg.	130.3	131.4	100.3
C <sub>R</sub>	Shipping costs to US (ROW proxy), US\$/kg.	0.287	0.304	0.432

Source: Norwegian Seafood Export Council and government statistics. <sup>a</sup> Prior to July 1.

**Table 2. Parameter Definitions and Values**

Item	Definition	Value <sup>a</sup>
Z <sub>N</sub>	Total domestic demand elasticity	-1.00
Z <sub>E</sub>	Total demand elasticity for EU	-1.93
Z <sub>J</sub>	Total demand elasticity for Japan	-1.46

$Z_R$	Total demand elasticity for ROW	-1.70
$\$N, \$E, \$J, \$R$	Total advertising elasticities for Norway, EU, Japan, and ROW	0.04
$*_E$	Shipping-cost elasticity for EU ( $= C_E(1 + T_E)/p_E$ )	0.05 <sup>b</sup>
$*_J$	Shipping-cost elasticity for Japan ( $= C_J(1 + T_J)/p_J$ )	0.16 <sup>b</sup>
$*_R$	Shipping-cost elasticity for ROW ( $= C_R(1 + T_R)/p_R$ )	0.08 <sup>b</sup>
$R_E, \succ_E$	Price transmission & exchange rate elasticities for EU	0.95
$R_J, \succ_J$	Price transmission & exch. rate elasticities for Japan	0.84
$R_R, \succ_R$	Price transmission & exch. rate elasticities for ROW	0.92
$J_E, J_J, J_R$	Export-tax transmission elasticities ( $= T_i / (1 + T_i), i = E, J, R$ )	0.0074
.	Farm-wholesale price transmission elasticity	0.724
$\cdot, r_{x,p}$	Quota-constrained farm supply elasticity	0 or 0.39
$\cdot, x,F$	Feed quota elasticity	0.61
$\phi_N$	Norway's quantity share ( $= q_N / x$ )	0.042 <sup>b</sup>
$\phi_E$	EU's quantity share ( $= q_E / x$ )	0.685 <sup>b</sup>
$\phi_J$	Japan's quantity share ( $= q_J / x$ )	0.093 <sup>b</sup>
$\phi_R$	ROW's quantity share ( $= q_R / x$ )	0.180 <sup>b</sup>

<sup>a</sup> See text for sources and details.

<sup>b</sup> Computed using average values for 1997-99 based on data given in table 1.

**Table 3. Reduced-Form Elasticities for Farm Price and Farm Quantity in Norway and Wholesale Price in EU and Export Quantity to EU**

Exog. Variable	Short-Run Elasticity <sup>a</sup>				Long-Run Elasticity <sup>b</sup>			
	$p^*$	$x^*$	$p_E^*$	$q_E^*$	$p^*$	$x^*$	$p_E^*$	$q_E^*$
$T_E^*$	-0.0080	0.0000	0.0019	-0.0037	-0.0061	-0.0024	0.0032	-0.0062
$T_J^*$	-0.0008	0.0000	-0.0006	0.0011	-0.0006	-0.0002	-0.0004	0.0008
$T_R^*$	-0.0018	0.0000	-0.0013	0.0024	-0.0014	-0.0005	-0.0010	0.0019
$A_N^*$	0.0014	0.0000	0.0009	-0.0018	0.0010	0.0004	0.0007	-0.0014
$A_E^*$	0.0223	0.0000	0.0154	0.0103	0.0170	0.0066	0.0117	0.0175
$A_J^*$	0.0030	0.0000	0.0021	-0.0040	0.0023	0.0009	0.0016	-0.0031
$A_R^*$	0.0059	0.0000	0.0040	-0.0078	0.0045	0.0017	0.0031	-0.0059

$Z_E^*$	-1.0021	0.0000	0.2608	-0.4633	-0.7602	-0.2965	0.4271	-0.7843
$Z_J^*$	-0.0899	0.0000	-0.0618	0.1193	-0.0682	-0.0266	-0.0469	0.0905
$Z_R^*$	-0.2235	0.0000	-0.1537	0.2967	-0.1696	-0.0661	-0.1166	0.2251
$C_E^*$	-0.0539	0.0000	0.0129	-0.0249	-0.0409	-0.0160	0.0219	-0.0422
$C_J^*$	-0.0177	0.0000	-0.0122	0.0235	-0.0134	-0.0052	-0.0092	0.0178
$C_R^*$	-0.0199	0.0000	-0.0137	0.0265	-0.0151	-0.0059	-0.0104	0.0201
*	-0.4975	0.6100	-0.3422	0.6605	-0.3775	0.4628	-0.2596	0.5011

<sup>a</sup> Computed with  $r_{x,p} = 0$ .

<sup>b</sup> Computed with  $r_{x,p} = 0.39$ .

**Table 4. Effects of Exogenous Variables on Farm Price, Farm Quantity, EU Price and EU Quantity, Norwegian Salmon Industry, 1997-99**

Exogenous Variable	% Change 1997-99 <sup>a</sup>	Effects (%) <sup>b</sup>			
		$p^*$	$x^*$	$p_E^*$	$q_E^*$
$T_E^*$	300.0	-1.82	-0.71	0.97	-1.87
$T_J^*$	0.0	0.00	0.00	0.00	0.00
$T_R^*$	0.0	0.00	0.00	0.00	0.00
3 $T_i^*$	--	-1.82	-0.71	0.97	-1.87
$A_N^*$	270.0	0.28	0.11	0.19	-0.38
$A_E^*$	254.3	4.31	1.68	2.97	4.45
$A_J^*$	92.0	0.21	0.08	0.15	-0.28
$A_R^*$	282.3	1.26	0.49	0.86	-1.67
3 $A_i^*$	--	6.06	2.36	4.17	2.12
$Z_E^*$	-4.0	3.04	1.19	-1.71	3.14
$Z_J^*$	-15.1	1.03	0.40	0.71	-1.37
$Z_R^*$	-9.9	1.67	0.65	1.15	-2.22
3 $Z_i^*$	--	5.74	2.24	0.15	-0.45
$C_E^*$	4.3	-0.18	-0.07	0.10	-0.18
$C_J^*$	-23.0	0.31	0.12	0.21	-0.41
$C_R^*$	50.5	-0.76	-0.30	-0.53	1.01

3 C <sub>1</sub> *	--	-0.63	-0.25	-0.22	0.42
*	12.4	-4.68	5.73	-3.22	6.21
Net Effect <sup>c</sup>	--	4.68	9.38	1.86	6.43

<sup>a</sup> Computed from data in table 1. <sup>b</sup> Computed using table 3's long-run elasticities.

<sup>c</sup> Sum of tax, advertising, exchange rate, shipping cost and quota effects.

**Table 5. Producer Benefits and Costs of Salmon Agreement, Norway, 1997-1999**

Item	Tax Effect	Advertising Effect					Net Effect	B-C Ratio <sup>a</sup>
		Norway	EU	Japan	ROW	All		
Scenario 1: <sup>b</sup>	(----- Million Kroners -----)							
Short Run	-527	74	1,125	55	328	1,582	1,056	3.00
Long Run	-398	56	860	42	249	1,207	809	3.03
Scenario 2: <sup>c</sup>								
Short Run	-527	62	950	47	277	1,336	809	2.54
Long Run	-398	47	726	35	210	1,019	621	2.56

<sup>a</sup> Advertising effect divided by absolute value of tax effect.

<sup>b</sup> Assumes that 90% of observed advertising increase is due to SA.

<sup>c</sup> Assumes that 76% of observed advertising increase is due to SA (see text for details).

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