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Simulating the Impacts of Trade Restrictions: An Application to the European Salmon Trade

by

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Abstract

During the last decade there has been a number of conflicts in relation to the trade of salmon in the EU. A current agreement between Norway and the EU includes a voluntary minimum import price agreement for exporters. A 13% tariff is paid by exporters that do not accept the agreement. We investigate the expected welfare effects of this tariff by analysing a general equilibrium demand curve. The results indicate that only Norwegian exporters are beneficial to target for EU producers. The total welfare effect of the tariff depends critical on the supply structure of EU and Norwegian salmon.

Keywords: import tariff, welfare measurement, trade policy, salmon market

JEL classifications: Q21, Q22, F13, F17.

1. Introduction

Aquaculture provides an important supplement to increase the supply of fish while stocks of wild fish are declining worldwide. Also in EU, where instruments that expand aquacultural production are implemented to increase the supply of fish, and hereby denying economic and social stagnation in fishery dependent communities in EU.[1)] Trade restrictions on imported fish are employed as means to protect and secure the aquacultural production within the Union.

Trade restrictions that are beneficial for the EU fish farmers are <u>not</u> necessarily beneficial for the EU industry from a more general point of view. Protection of a "domestic" industrial segment that has competitive disadvantages internationally might reduce the "domestic" social welfare. This argument is relevant in relation with the salmon production in EU, where trade restrictions are imposed to keep up prices on farmed products. However, for intermediately industries and consumers, the high prices and low import quantities are unfavourable. An appropriate method to study the effects of the trade restrictions is to compare gains and losses for the industries in EU. This paper addresses the economic welfare impacts for the industry in EU of a tariff on import of Norwegian salmon. The analysis is conducted by estimating the demand for salmon at the intermediate industry level.

Much of the demand literature in the salmon markets uses import and export data, but use model specification for final consumers (see e.g. Bjørndal, Salvanes and Andreassen, 1992; DeVoretz and Salvanes, 1993; Herrmann, Mittelhammer and Lin, 1993; Bjørndal, Gordon and Salvanes, 1994; Asche, 1996, 1997 and 2001; Asche, Salvanes and Steen, 1997; Asche, Bjørndal and Salvanes, 1998, Kinnucan and Myrland, 2002a).[2)] It is common knowledge that the separability assumptions commonly made when estimating import demand equations, based on the consumer theory, is not likely to hold (Winters, 1984; Alston *et al.*, 1990). This assumption can lead to inconsistent estimates of the elasticities. Furthermore, since this is derived demand, the signals from the consumer level will thus in general be distorted in the

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[1] The Treaty of Rome, 25 March 1957, Article 39(1): ii) and iv). A Strategy for the Sustainable Development of European Aquaculture. Commission document COM(2002) 511 final. Brussels 19.9. 2002.

[2] Kinnucan and Myrland (2000; 2002a) analyse issues in relation to the recent salmon agreement between EU and Norway in an equilibrium displacement setting based on estimated parameters from earlier studies.

value chain (Gardner, 1975). To avoid these problems, we will model the import demand equations as derived demand for a European intermediary industry. This has two main implications. Firstly, the firms in the intermediate industry are assumed to optimise their behaviour by buying salmon at a given quality to the lowest possible price. A tariff that increases the import price of salmon from a specific origin implies that the firms respond by altering their composition of salmon demand. Secondly, by employing the intermediate industry perspective we estimate the welfare consequences in the horizontal markets surrounding the intermediate industry. The approach thereby represents an alternative to the estimation of welfare consequences vertically downstream the value chain as suggested by Just and Hueth (1979). Theoretically, it well known the tariff is shared between the demand and supply industries based on the relative elasticities of the demand and supply side. Lack of the necessary data to estimate the salmon supply industry denies us from making econometric estimation on the supply side elasticities. As an alternative avenue, we employ alternative values of supply elasticities to simulate scenarios of economic surpluses obtained. In addition the partial demand elasticities in the horizontal markets are used for estimating a general equilibrium demand function for salmon.

This paper is organised as follows. In the next section the model describing the welfare impact of the import tariff is presented. Applied to the salmon market, sections 2, 3, and 4, respectively, describes the development of the salmon trade in EU, the setting up of an empirical import demand model, and presents the empirical results based on the model. In section 5, the simulated welfare results are presented and discussed. A summary of findings and perspectives in relation to the Common Fishery Policies (CFP) is outlined in the final and concluding section.

2. Welfare Impact of Import Tariff

The commercial salmon sector consists of a vertical integrated value chain from primary producers (fish farmers/fishermen) to final consumers. In the following, we measure the welfare impact of trade restrictions in horizontal markets at the import or the intermediary industry level.[3)] This industry consists of a large number of trading firms, and the input and output markets of the trading firms are assumed competitive. Raw fish supplied from domestic and foreign sources is input to the intermediary industry. The output of the intermediary industry is assumed to consist of a composite salmon output supplied to the intermediary/detail industry.

Just and Hueth (1979) emphasise that the area behind a general equilibrium demand curve in a intermediate market measures the sum of rents to producers selling in all higher markets (assuming no intervening market has perfectly elastic demand), plus the surplus of the final consumers. Assume a horizontally integrated industry that supplies a single output by the use of inputs q and q'. The input q is imported input and q' are supplied by domestic producers. The industry maximises short run profit, π. The output and input prices are exogenous as they are determined in competitive markets. Employing Hotelling's lemma derives the intermediary industry's input demand functions under profit maximisation. The demand of the imported input is given by $\delta\pi/\delta p$

[3] By intermediary industries we mean anybody handling salmon from the EU border including both traders and fish mongers who's only contribution is to transport fresh unprocessed fish to the consumer and traditional processors like smoking houses.

$$q = q(p, p', Y) \quad \delta q/\delta p < 0, \delta q/\delta p' > 0, \delta q/\delta Y > 0, \tag{1}$$

where q measures the quantity of imported input, which depends on the import price, p, the price on the domestic input p' and the output price Y. A similar equation can be specified for the demand of the domestic goods.

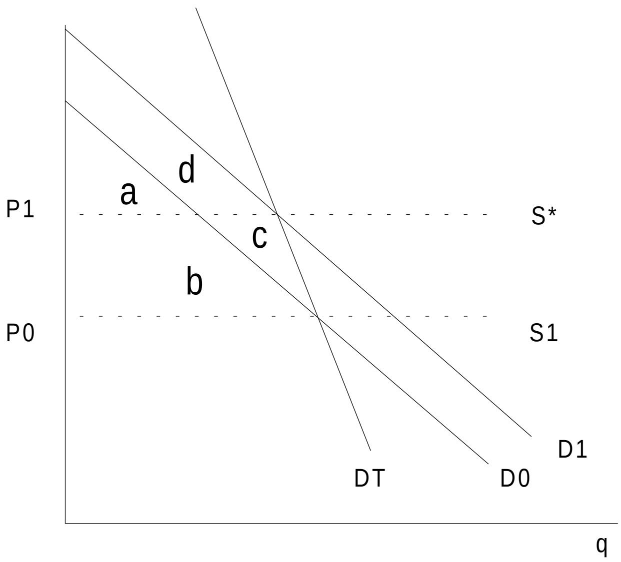
The short run supply of domestic input is given by

$$q' = q(p', p_x', w) \quad \delta q'/\delta p' > 0, \delta q'/\delta p'_x < 0, \delta q'/\delta w > 0, \tag{2}$$

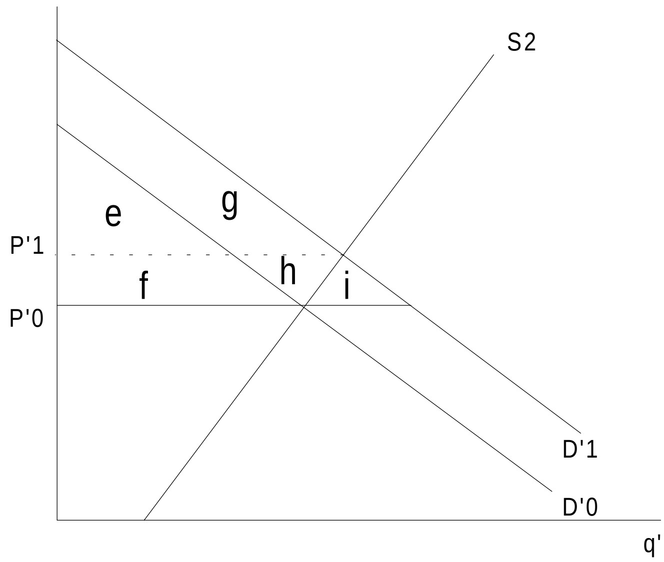
where p_x' is the supply price to other markets and the input cost of the domestic supply industry, denoted w.

The welfare impacts of imposing a tariff on the imported input are illustrated in figure 1, where figure 1.a indicates the market for imported input, and figure 1.b is the market for domestic produced input. Before the import tariff is imposed the equilibrium price in the market for imported and domestic produced inputs are respectively PO and P'O. Imposing the tariff on the imported input means that the supply is curve in figure 1.a shifts from S1 to S*. Moreover given the inputs q and q' are substitutes in the intermediary production this means that the demand of domestic produced input in figure 1.b increases from D'0 to D'1 as a consequence of the tariff.

Figure 1. The Equilibria in the Input Markets



(1.a)



(1.b)

The partial equilibrium builds on the assumption of constant price in the market for the domestic input in figure 1.b, and fixed output price. Both imported and domestic inputs are essential in the production of the intermediary industry implying positive quantities of both inputs are needed. Just, Hueth and Schmitz (1982) emphasise that when both inputs are essential to the intermediary industry this is a sufficient condition for deploying quasi rents in the markets separately.[4)] In the partial equilibrium, the fixed price in the market for domestic input, figure 1.b, implies that the tariff increases the intermediary industry's surplus by the area g+h+i, and the domestic suppliers do not obtain any surplus. The net welfare consequence in the partial equilibrium is measured entirely in the tariffed market, figure 1.a, to a net loss of the area b, the net loss takes explicitly into account of the gain (area g+h+i) obtained in figure 1b.

The general equilibrium demand does not assume that prices remain fixed. Instead the tariff might impact the entire price structure in the submarkets along the market chain from primary to the final consumer. In the following, we employ the general equilibrium demand in the restricted setting inspired by Just and Hueth (1979). We assume that the prices in the horizontal markets for inputs, in figure 1.a and figure 1.b, are variable, but other prices along the market chain are assumed constant. In this setting, we find that the tariff on the imported import input accommodates a price increase to P'1 in the domestic market in figure 1.b. This means that the supplier of domestic input obtains a surplus of the area f+h.[5)] On the other hand, the surplus of the demand industry, in figure 1.b, is reduced by the area -f-h-i compared to the partial equilibrium. Summing the gainers and losers of the tariff in the domestic market, we find a net loss of the area i when comparing the general and partial equilibrium. In our general equilibrium, we can measure the welfare impact of the tariff entirely in figure 1.a by measuring the impact of the price in the figure 1.b. This is accomplished by measuring the impact that the increased price in figure 1.b will have on the demand on the imported input in figure 1.a. through shift in the demand from DO to D1. We obtain the general equilibrium demand curve DT that takes explicitly into account the prices increase in figure 1.b., and the net loss in a general equilibrium setting can entirely be measured as the areas b+c in figure 1.a. Thurman (1993) show that the area i in figure 1.a is equal the area c in figure 1.b. The latter means that the area c measures the net impact of demand and supplier in the domestic market. Therefore measuring the general equilibrium welfare impacts on the tariff we find the domestic producer obtain a gain of the area f+h, whereas the intermediary industry obtains a loss of the area –b-c-f-h.

3. European Salmon Demand

Prior to model specification, a description of the salmon trade in EU is in order. During the last two decades, a significant growth in demand for salmon has occurred in the EU. The continental EU (CEU) states obtain the bulk of the import of salmon to the EU, and these states have practically no production of salmon. Between 1992 and 1996 the CEU states' import of salmon increases by 50% from 214,870 tonnes in 1992 to 325,126 tones in 1996, of which respectively 22,823 tones and 43,977 tones was imported from the EU partners Ireland and Scotland.[6)] Figure 2 indicates the seasonal pattern in the consumption, which peaks during the autumn and the Christmas. In term of product type about 70% of the total import is fresh salmon and 16-17% are frozen, the rest is various kinds of processed salmon.

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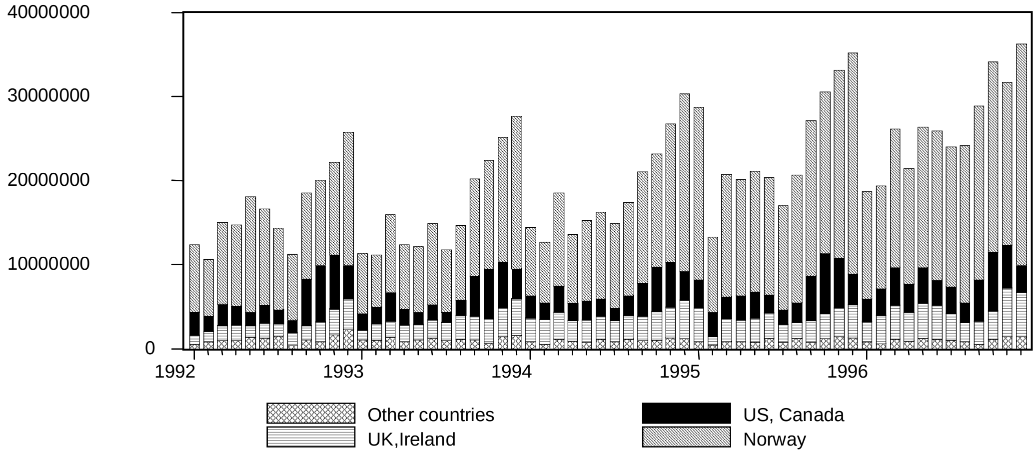
[4] The intermediate industry in EU cannot maintain its production level without imports, as the EU production is too small.
[5] Builds on the assumption that P'O represents the average production cost.
[6] The quantities of imports are measured in round weight.

Figure 2. Development in the Quantity of Imported Salmon by the CEU States (quantities in kilos of round weight on a monthly basis)



Between 1992 and 1996, 66.1% of the CEU states' total import quantity (round weight) of salmon is imported from Norway. Norway's share of the total imported quantity to EU varies between 61-64% in 1992-1994 to about 70% in 1995-1996. Most of the import from Norway is fresh salmon. A large share of wild salmon is imported from Canada and US, but the input of wild fish have decreased steadily from 11% in 1992 to 8% in 1996. The US/ Canada import is frozen salmon.

The import from Scotland and Ireland to the CEU States provides a fairly stable market share of 14-16% of total import in the period 1992-1996. In absolute terms, an increase in the imported quantities has followed the development of the fish farm industry in Scotland and Ireland. Between 1992 and 1996 the total production of salmon in Scotland and Ireland increased from 46,000 tones in 1992 to 97,300 tones in 1996.[7)] 80% of the CEU States' import from Scotland and Ireland is fresh salmon and 12-17% is smoked. The explanation that the share of smoked salmon is relatively high in the import from Scotland and Ireland compared with the 2% in the import from Norway, follows from the 2% fee on unprocessed salmon and 13% on processed salmon on the imports from Norway.

Finally, CEU States import salmon from a number of other countries, in particular from Chile, Faeroe Islands, China, and Russia. The market share of these countries has decreased from 12-11% in 1992-1993 to about 6% of the annual import in 1995-1996. The mixture of product type varies with the destination of the import. Producers close to the EU market supply the fresh products.

4. Empirical Model and Data of Import Demand for CEU States

A central theme, when developing a salmon demand model, is whether segmented markets or a single world market provide the most suitable description. Hermann and Lin (1988) employs a model that assume segment markets by estimating separate demand and supply functions for each of the main markets (Japan, USA and the EU), while Bjørndal and

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[7] Source: Globefish (Commodity Update Salmon) September 2000. Produced supply measured in round weight.

Schwindt (1991) argue that the market is global and competitive. DeVoretz and Salvanes (1993) and Steen and Salvanes (1999) found some evidence of short-run market power in the eighties, while more recent studies indicates that the market is global and competitive (Asche, Bremnes and Wessels, 1999 and Asche, 2001). Several studies support this notion as they found prices in submarkets to be exogenous in empirical tests (DeVoretz and Salvanes, 1993; Asche, 1996; Asche, Salvanes and Steen, 1997; and Asche, Bjørndal and Salvanes 1998). The determination of the salmon price in the world market supports the notion that the price is exogenous to the European fish industry. In this sense, assuming that supply of salmon is perfectly elastic to the European market in the short run, it is possible to accommodate inference on import tariff based on demand conditions in the market.

Information relevant to describe demand conditions is expressed by own- and cross- price elasticities on import demand. Cross price elasticities that relate demand from Scotland and Ireland with the import from other origins are valuable in the assessment of the extent the CEU States increase their demand of Scottish/Irish salmon as restrictions are imposed on import from other origins.

Modelling the CEU states import demand is based on distinguishing imports of four origins: Norway, US/Canada, Scotland/Ireland and "other". The four categories form homogenous groups with respect to product type and quality. In order to reduce the number of parameters, aggregated import data is employed and the specification of different product types (fresh, frozen, etc) is avoided. The aggregates are measured in round weight, and different product types are thus measured in equivalent weight unit. From a management point of view, obtaining information of elasticities on aggregated level facilitates the administrative process of imposing trade restriction, because the tariff is supposed to be imposed on all product types from a certain origin.

We focus on salmon from different sources and assume that the salmon input is weakly separable from other inputs (labour and capital). While this in general is a strict restriction, it is reasonable in the industry considered here as capacity often is fixed and production levels are adjusted by entry and exit of firms (Asche *et al.*, 2002). The budget share for the fish is also often very high for fish processors (Toft and Bjørndal, 1997). Finally, Asche, Bremnes and Wessells (1999) indicate that the Generalised Composite Commodity Theorem of Lewbel holds for salmon for different producers.[8)] This provides empirical evidence in favour of our aggregation assumption as this implies that salmon can be treated as a group separable from other factors.

A double log functional form is used to estimate the salmon demand for the intermediate industry in the European market. The form is particular easy to use and has the advantage that elasticities and their standard deviations are directly observable. The double log import demand system is given as,

$$\log qm_n = \alpha_n + \sum_{k=4} \alpha_{n,k} \log pm_k + \beta_n \log Y_{EU} + \sum_s \gamma_{n,s} D_s + \sum_l \varphi_{n,l} D_l \,, \qquad (3a)$$

$$\log qm_{eu} = \alpha_{eu} + \sum_{k=4} \alpha_{eu,k} \log pm_k + \beta_{eu} \log Y_{EU} + \sum_s \gamma_{eu,s} D_s + \sum_l \varphi_{eu,l} D_l \qquad (3b)$$

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8 Please note that Varian (1992) denotes the composite commodity theorem as Hicksian separability.

$$\log qm_{us} = \alpha_{us} + \sum_{k=4} \alpha_{us,k} \log pm_k + \beta_{us} \log Y_{EU} + \sum_s \gamma_{us,s} D_s + \sum_l \varphi_{us,l} D_l \quad (3c)$$

$$\log qm_o = \alpha_o + \sum_{k=4} \alpha_{o,k} \log pm_k + \beta_o \log Y_{EU} + \sum_s \gamma_{o,s} D_s + \sum_l \varphi_{o,l} D_l \quad (3d)$$

where variables follows as,

qm_n - the imported quantity of salmon (measured in kilo of round weight) from Norway.

qm_{eu} - the imported quantity of salmon (measured in kilo of round weight) from Scotland/Ireland.

qm_{us} - the imported quantity of salmon (measured in kilo of round weight) from US/Canada.

qm_o - the imported quantity of salmon (measured in kilo of round weight) from other origin.

pm_k - the imported price of salmon (measured in EU per kilo of round weight) for k=n,uk,us, and o that is for respectively from Norway (n), UK (Scotland and Ireland), US (USA and Canada), and others (o).

Y_{eu} - the index of the output price development in the CEU States.

D_s - seasonal monthly dummies

D_l – structural shift in supply of Norwegian salmon

The parameters follows as,

α_i for $i \in \{n,uk,us,o\}$ - denotes the constant terms.

$\gamma_{i,s}$ for $i \in \{n,uk,us,o\}$ and $s \in \{1,2,\ldots,12\}$ - denotes the constant dummy terms for season.

$\varphi_{i,l}$ for $i \in \{n,uk,us,o\}$ and $l \in \{0,1\}$ - denotes the constant dummy terms for structural shift that is measured by a 0 between 1992:1 and 1994:12 and a value of 1 from 1995:1 to 1996:12.

$\alpha_{i,i}$ for $i \in \{n,uk,us,o\}$- denote the own demand price elasticities.

$\alpha_{i,j}$ for $i,j \in \{n,uk,us,o\}$ and $i \neq j$- denote the cross demand price elasticities.

β_i for $i \in \{n,uk,us,o\}$ - denote the elasticities between output price and quantities of demanded inputs.

Linear homogeneity between input and output prices is imposed on the import demand system. Monthly data provided by the Norwegian Seafood Exports Council and Eurostat are used to estimate the demand system (3a) to (3d). The current prices and quantities of salmon are measured in round weight to obtain aggregated measures. Ideally, the intermediary industry's output price to the intermediary/detail industry should have been used in the model. Unfortunately, we have not been able to obtain the intermediary industry's output price. Instead we have applied the development of the GNP price index in the CEU States as an indicator of output price. The output price index is constructed based on the import weights of salmon in each CEU State times the price GNP price. The prices are calculated in Euro.

5. Empirical Results

The import demand system specified, in (3a)–(3d), is estimated by SUR estimation in the period 1992:1 and 1996:12. The significant deterministic constant term shifting the import demand of Norwegian salmon in the period 1995:1 to 1996:12 is found. This structural dummy shift measures an increase in the share of imported quantities from Norway as mentioned in the description of the trade pattern. The trade pattern described in the previous section indicates that the import shares from US/Canada and from other origins decreased in 1995-1996, but no evidence of the structural shift is found in import demand functions for UK/Ireland, US/Canada or from other origins. This structural shift is most likely caused by a substantial increase in Norwegian production. The structural shift might occur due to the introduction of oil vaccines that increases productivity or might indicate dumping of Norwegian salmon into the EU market. However, we have modelled the structural shift as a simple dummy variable, and we cannot give any conclusive explanation of the shift.

No indication of autocorrelation is found in the estimations. The R-squares are acceptable but with exception of the equation for imports from other origin, where 48% variation in import demand quantity is explained. This is not surprising as the import only contains about 6% of the total import value.

Table 1. *Estimation of CEU States' Import Demand of Salmon by Origin*[1), 2)]

	Quantity imported from			
Regressors	Norway	Scotland/Ireland	US/Canada	Other origin[3)]
Price, Norway	-1.456**	0.949**	-0.307	-0.183
	(-6.243)	(2.827)	(-0.953)	(-0.423)
Price, Scotland /Ireland	0.969**	-1.681**	0.545*	-0.158
	(4.414)	(-5.495)	(1.868)	(-0.415)
Price, US/Canada	-0.312	-0.401	-0.896**	0.603*
	(-1.206)	(-1.581)	(3.884)	(1.939)
Price, others	-0.070	0.190	0.343**	-0.386**
	(-0.568)	(1.419)	(2.669)	(-2.377)
Output Price	0.869**	0.942**	0.364**	0.125
	(4.752)	(5.249)	(2.135)	(0.579)
Constant	13.22**	11.866**	13.112**	13.676**
	(22.337)	(21.236)	(24.493)	(20.186)
Monthly dummies	2,9,10,11	2,11,12	7,8,9,10,11,12	1,2,11,12
Structural shift	0.273**			
1995:1- 1996:12	(3.852)			
R-square	0.803	0.747	0.840	0.486
SEE	0.177	0.207	0.202	0.251
DW	2.026	1.711	1.655	2.178

** Significant at 5% level, * significant at 10% level.
t-statistics are reported in parentheses.
1) Denote that imported salmon only represents the continental EU States thereby excluding United Kingdom and Ireland.
2) Other origin covers the import of salmon from Russia, China, Chile, and Faeroe Islands.

The own- and, cross- price elasticities and their t-values are reported in table 1. The empirical estimates reveal seasonal fluctuations in import demand. The high season of import from all origins is the months from October to December, and the low season of import is in February. The high season of salmon import from US/Canada is stretched from July to December. The high season of the pacific wild salmon fishery is during the summer, hereafter the salmon is stored and gradually sold to the EU market during the second half of the year. The production of farmed salmon in Europe follows another pattern, here the production is at the highest during the late fall and therefore just in time to meet the high season of the salmon import to the CEU market.

The Marshallian own price elasticities for Norway and Scotland/Ireland are elastic, indicating that a 1-% increase in the price gives a fall in the demanded quantity of more than 1%. On the other hand, inelastic elasticities are observed for the imports from US/Canada and other origins. The price insensitivity revealed for imports from US/Canada and the rest group is probably due to the low absolute quantities of imports from these countries. The present results are in line with the findings of Asche, Bjørndal and Salvanes (1998) who obtain own price elasticities in the range between -0.514 and -1.856 for European market in the period 1984 and 1992.

The cross price elasticities indicate that the European salmon import is divided in two sub-markets. In the first market, salmon from Norway and Scotland/Ireland compete. The second submarket consists of imports from US/Canada that competes with imports from other origin. The only exception that suggests some relation between the imports of European origin (Norway, Scotland and Ireland) and imports from overseas, is that the price of Scottish/Irish salmon has an impact on the import quantity from US/Canada. However, this cross price relation is indicated to be significant at a 10% level only. In all other cases the result indicates separated submarkets for the demand of salmon. The result might indicate a separation based on product type between the imported fresh salmon from Norway, Scotland and Ireland, and the frozen salmon imported from US/Canada and other origin on the side. Nevertheless, the impression cannot be confirmed by the estimation, because specification by product type is not conducted. Asche, Bjørndal and Salvanes (1998) found a lack of substitution between fresh Atlantic and frozen Pacific in the European market. Difference in product quality might by a reason for separated markets. This is also indicated by a significant difference in import prices by origin. The average import price of salmon from Norway, Scotland and Ireland is about 50% or about 1.25 Euro per kilo above the import price of salmon from US/Canada and from other origin. This price difference confirms the impression of markets that are segmented by product quality.

The elasticities on the output price nearly indicate a one to one relation between output price and quantity demanded salmon from Norway, Scotland and Ireland. On the other hand, the empirical result indicates a declining relationship between the demand of salmon from US/Canada and the rest group and the output price. The last condition of a decreasing import shares for the lower quality products of frozen salmon is not surprising given that increasing output price corresponds increased demand after products of higher quality.

From EU's point of view, in their effort to increase production of salmon farmed in EU, the empirical analysis reveals that the Scottish/Irish salmon is mainly competing with the salmon imported from Norway. Imposing a trade restriction on the import from Norway will thus be relevant. Different scenarios of imposing such import restriction are addressed in the following.

6. Result and Discussion of Import Tariff Simulations

Imposing trade restriction on import of salmon to the EU market is motivated by the objective to increase the demand of fish supplied by the domestic EU industry. Depleted wild stocks and needs to increase the total supply of fish in the EU, on the other hand, speak against trade restriction on imported fish. However, based on the premise that EU decides to impose trade restrictions on salmon import it seems reasonable to restrict the import from Norway. This follows because the imports of salmon from Norway, due to estimation presented in table 1, is the main competitor to Scottish/Irish salmon. Imposing trade restrictions on salmon imported from either US/Canada or from other origin is not relevant because it will not increase the demand of Scottish/Irish salmon and thereby gain domestic fish suppliers in EU. The impact of the import tariff depends on the import demand elasticity, the import supply elasticity, and the cross price elasticity between domestic and imported salmon.

The own- and, cross- price demand elasticities (see table 1) are based on the assumption of perfectly elastic import supply. This means that the tariff does not induce the supplier to change the supply price. Instead, the supplier responds to the import restriction by substituting to other non-tariffed export markets. The import tariff thus has the consequence that it increases the import demand price paid by the intermediary industry. The assumed import supply elasticity addresses the ability of the supplier to circumvent the import tariff by altering the export markets. The more elastic the import supply is, the less incidens falls on the import supplier.

Three scenarios simulate the consequence of the import tariff here. In the first, it is assumed that the import supplies of Norwegian and Scottish/Irish salmon are perfectly elastic, which is accounted for by the partial equilibrium demand. In the second scenario, we assume that that Norwegian salmon supply is perfectly elastic, whereas demand and supply elasticities of Scottish/Irish salmon are symmetric. The latter condition implies that the import tariff leads to an increase in the price of Scottish/Irish salmon and thereby positive surplus of Scottish/Irish producers, similar to the general equilibrium demand curve illustrated in figure 1. Finally, symmetric demand and supply elasticities for all origins are simulated under the last scenario meaning benchmark supply elasticities of Scottish/Irish, Norwegian, US/Canadian and other origins are -1.681, -1.456, -0.896, and -0.386, respectively. Symmetric demand and supply elasticities of Norwegian salmon under the last general equilibrium scenario embodies that the tariff is shared among EU's demand industry and the Norwegian suppliers.

In the salmon agreement of 1997, the EU suggested a 13% import tariff on import of Norwegian salmon. This level of sanction is seen as a likely outcome if Norwegian authorities decide not to renew the salmon agreement that runs to 2002 in some form. The proposed tariff is thus used as benchmark in the present simulations. The simulations build on the assumption that no import tariff is placed on salmon from US/Canada and the group of other origin, because restrictions on this import does not increase the demand of Scottish/Irish salmon in the EU.

Table 2. *Simulating a 13% Import Tariff on Norwegian Salmon to EU.*[1), 2), 3)]

	Ex ante No tariff	Scenario 1 13% tariff, elastic supply curves	Scenario 2 13% tariff, increasing supply curve EU and elastic supply curve Norway	Scenario 3 13% tariff, increasing supply curves EU and Norway
		partial equilibrium demand	general equilibrium demand	general equilibrium demand
Monthly effect				
Import Scotland/Ireland, ton	2767.431	3108.849	2938.140	2852.785
Import Norway, ton	13287.394	10772.235	12446.169	12657.058
Import USA/Canada, ton	3340.122	3340.122	3340.122	3340.122
Import other countries, ton	1970.729	1970.729	1970.729	1970.729
Total import, ton	21365.676	19192.056	20695.160	20820.694
Import Scotland/Ireland, Euro per kilo	4.242	4.242	4.398	4.320
Import Norway, Euro per kilo	3.667	4.144	4.144	4.024
Import USA/Canada, Euro per kilo	2.038	2.038	2.038	2.038
Import other countries, Euro per kilo	3.257	3.257	3.257	3.257
Total import, Euro per kilo	3.449	3.702	3.756	3.673

1) In the simulations of imported salmon to the continental EU States is considered thereby excluding imports to United Kingdom and Ireland.
2) Quantities and price per kilo are measured in round weight.
3) Simulations are based on the Marshallian elasticities.

The first column in table 2 represents actual figures of EU's import of salmon by origin *ex ante* that is before the import tariff is imposed. The figures indicate that EU imports 21365 ton of salmon per month (average), and the average price is 3.449 Euro per kilo. All figures are based on average figures obtained in the period 1992:1 to 1996:12.

The second column represents the situation *ex post* that is after the 13% import tariff on Norwegian salmon is enforced. The assumption of perfectly elastic salmon supply means that the tariff increases import demand price by 13% and quantity of imported Norwegian salmon decreases with 18.9%. In the partial equilibrium, the price of EU produced salmon is assumed to remain constant. This means that the demand of Scottish/Irish salmon increases with 12.3% to 3108 tons. Demand of salmon from US/Canada and other origins will due to insignificant cross price elasticities not be affected by the tariff on the Norwegian salmon. This follows due to segmented markets for fresh and frozen salmon. In total, the 13% tariff on import from Norway means the average monthly price rises 7.3% from 3.449 Euro per kilo to 3.702 Euro per kilo.

The introduction of an increasing supply function of Scottish/Irish salmon presented in the third column of table 2, means that the tariff increases the price of Scottish/Irish salmon. Keeping the assumption of a perfect elastic supply of Norwegian salmon means that the demand industry in EU pays the tariff entirely, because the Norwegian suppliers are able to substitute to other export markets, and thereby keeping their export price constant. By employing the general equilibrium demand, the total demand elasticity follows because the increase in price of the EU produced salmon shifts the demand curve for Norwegian salmon.

The total elasticity of demand, illustrated by the DT curve in figure 1.a, is calculated from: $\eta'_{ii} = \eta_{ii} - \eta_{ij}\rho$, where η_{ii} is the partial elasticity. η_{ij} is the cross price elasticity, and ρ is the cross-price transmission elasticity. The latter elasticity indicates the impact of a percentage change in the price of Scottish/Irish salmon transmitted to the import price of Norwegian salmon. The parameters η_{ii} and η_{ij} are obtained from table 1, and the value for ρ is assumed to be unity. Thereby, the total import demand elasticity of Norwegian salmon calculated to 0.487. The total demand curve is more inelastic than the partial demand curve. The tariff increases the import price of Norwegian salmon with 13% and reduces the import with 6.3% to 12446 tons. The raise in import price of salmon from Norway expands the price of Scottish/Irish salmon by 3.7%. However, substitution from Norwegian towards Scottish/Irish salmon means the demand of EU produced salmon increases from 2767 ton to 2938 ton per month. In total, the 13% tariff increases the average salmon price from 3.449 to 3.756 Euro per kilo and total import decreases from 21365 ton to 20695 ton per month.

The import tariff is shared among the demand and supply sides as long neither demand or supply elasticities are perfect elastic. In the fourth column, the situation when demand and supply elasticities are symmetric is considered. This means that Norwegian suppliers pay a part of the tariff. However, in the general equilibrium demand setting, the tariff will not be distributed equally between the import demand industry in EU and the Norwegian suppliers, because asymmetric elasticities are obtained when relating the general equilibrium demand function with the partial supply function. In our example, we find the EU import industry pays 74.9% of the tariff. The 13% tariff means that the import price of Norwegian salmon increases with 9.7% to 4.034 Euro per kilo, and the Norwegian suppliers decrease their export price by 3.3% to 3.545 Euro per kilo. Finally the scenario means that the average aggregated import price increases by 6.5% to 3.673 Euro per kilo and the total imported quantity decrease by 3.6% to 20820 tons per month.

The simulations indicate that the import tariff reduces traded quantities and increases prices on salmon in the European market. In this sense, the tariff is a loss of the salmon demand industry and gains the fish supply industry in Scotland and Ireland. However, in order to undertake a specific comparison of the obtained gains and losses, the welfare consequences of the import tariff is addressed. To do so we calculate the welfare consequences of the import tariff in the horizontal markets for imported and domestic farmed salmon (Just, Hueth and Schmitz, 1982). In so doing, it is assumed that the demand and supply curves in the import market and the domestic market are linear. The estimated point elasticities from table 1 and the simulated figures from table 2 are used in the calculation of the welfare impacts that are presented in table 3.

Table 3 indicates that the EU industry, i.e. the demand and supply industry, obtains a net welfare loss as result of the import tariff. This follows because the gain of EU's fish supply industry in no case is able to offset the loss of the fish demand industry. The result is a consequence of the demand conditions in the European market, whereby the import tariff leads to a major reduction in import of Norwegian salmon. Substitution towards EU-produced salmon is insufficient to prevent an entire reduction in the supply of salmon to the industry. Positive producer surplus for the Scottish/Irish producers is obtained under imperfect elastic supply since the tarrif increases the supply price obtained by the EU producers that is in scenario 2 and 3, whereas no increase in producer surplus is obtained under the first scenario. The EU's producer surplus is highest when the supply of Norwegian salmon is perfect elastic, because this gives the highest demand and price of EU produced salmon. The total industrial loss in EU, i.e., to the demand and supply industries in EU, is highest (-6137455 Euro per month) under the second scenario. This follows due to two conditions. Firstly, because the loss of the demand industry is higher in the general equilibrium demand than in the partial equilibrium, thereby explaining the reason scenario 1 gives a larger loss than scenario 1. Secondly, in the scenario 2 the demand industry in EU finances the tariff entirely, this is not the case in scenario 3, where the Norwegian suppliers pay a part of the tariff through reduced supply prices.

Table 3. *Scenarios for Welfare Impacts of a 13% Tariff on EU's Import of Norwegian Salmon[1)] (measured in currency of Euro, monthly effect)*

	Scenario 1 13% tariff, elastic supply curves partial equilibrium demand	Scenario 2 13% tariff, increasing supply curve EU and elastic supply curve Norway general equilibrium[2)] demand	Scenario 3 13% tariff, increasing supply curves EU and Norway general equilibrium[2)] demand
Monthly effect			
Demander loss in EU	-5734762	-6581459	-4636523
Producer surplus in Scotland/Ireland[3)]	0	444005	218705
Aggregated impact on EU industry	-5734762	-6137455	-4633711
Aggregated import tax yield to EU	5135290	5936823	6039979
Net welfare loss/gain for EU	-599472	-200632	1406268

1) In the simulations of imported salmon, the EU only represents the continental EU States thereby excluding United Kingdom and Ireland.
2) Based on a total demand elasticity (see Buse, 1958).
3) The calculation of the producer surplus bases on a constant average production cost of 4.242 Euro per kilo meaning that zero producer surplus is assumed *ex ante* for the EU producers.

The import tariff leads to a tax-revenue obtained by the EU tax authorities. Looking at the EU tax authorities and the EU industry as a whole, a net loss is obtained under scenario 1 and 2 whereas a net gain is obtained under scenario 3 that is with imperfect elastic supply of Norwegian salmon. This result is not surprising, but follows because the Norwegian supplier reduces their supply price due to the import tariff. EU's import demand industry covers the whole tariff, when supply of Norwegian salmon is perfectly elastic. Norwegian salmon supplier pays a part of the import tariff by reducing their export price, when their supply is imperfect elastic. Although, the partial demand and supply elasticities are symmetric, the import demand industry in EU pays a higher share of the import tariff than the Norwegian supply industry. This follows because asymmetry between elasticities of the general equilibrium demand and the partial supply implies that the demand industry in our case pays 74.9% of the tariff. However, it is worth noting that under the scenario 3, the EU taken as whole, i.e. including industry and tariff authorities, obtains a net gain of 1406268 Euro per month, which follows because Norwegian suppliers contribute paying the tariff. Although, the trade restrictions are foremost implemented to increase the economic standard of living of the EU salmon farmers, the gain obtained by these EU farmers only makes up for 5-7% to the loss obtained by the import demand industry in EU. In general the European tax authorities are the main gainers under the import tariff regulation. Hence, strategic trade policy reasoning gives a rational for the EU to introduce a tariff. If scenario 3 is regarded as the most likely, the fact that the EU in the salmon agreement has been willing to undertake other measures that are beneficiary to the domestic salmon industry but without obtaining the tax revenue is an indication that such considerations are not given weight.

The simulations of welfare consequences in the present analysis measure the impact of the import restriction horizontally in the intermediary market of Norwegian and Scottish/Irish salmon. Vertical links in the markets chain for example measuring impacts on the processed salmon in EU or employment effects in the European fish farming industry are therefore not accounted for in the presented analysis. The present simulations build on the assumption of perfectly elastic demands downstream the market chain. In this sense the present study underestimates the potential loss of the tariff. To our knowledge, no studies has been conducted to estimate the welfare losses of a tariff in the markets level of intermediary/detail industry or final consumers, but we would expect that the price elasticities in the downstream markets are larger in magnitude due to a larger range of different substitutes at these markets level. In this sense, the main share of the welfare loss should be covered in our analysis. However, extending the analysis to cover the downstream markets would be an interesting extension of the present study.

Limitations in potential to expand the salmon farm industry in EU and thereby to obtain an economic gain of import restrictions are seen on the short- and medium term. This follows because salmon production is a function of available space in the coastal zone; space as defined by the requirements of salmon aquaculture. Limitations in the coastal capacity for aquaculture production are defined by the acceptable organic loading of the water body, and an assessment of available area after subtracting area already defined (for various reasons) as unfeasible for aquaculture. This unsuitability may be due to natural conditions as ice problems, heavy currents, or areas open to heavy weather. Other unsuitability measures are pollution and areas occupied by other users (fishermen, tourist enterprises, the navy, public constructions) (Ibrekk *et al.*, 1993, Tveterås, 2002). Limited possibilities extending the Scottish/Irish production are seen because of expose to heavy weather, etc. Moreover an increase of the Scottish/Irish salmon supply means that less productive coastal areas would be put into production, which itself would increase the average production costs, and put a upper bound on the producer surplus obtained in the industry.

7. Conclusion

In this study we investigate the effect of imposing a 13% tariff on Norwegian imports to the EU, which is seen as the “maximum penalty” if the present salmon agreement between the EU and Norway breaks down. The results complements those of Kinnucan and Myrland (2000; 2002a, b). Our approach differs from other specifications in the literature by modelling import demand as derived demand for an intermediate industry. The general equilibrium demand curve of Just and Hueth (1979) is then used to investigate the effects of the tariff.

The empirical result indicates that the salmon produced in EU predominantly competes with the salmon produced in Norway. A tariff imposed on imported Norwegian salmon will therefore lead to an increase in the demand for salmon produced in the EU. However, the market simulations of economic benefits indicate that a tariff most likely will be welfare reducing for the EU industry and consumers. The gain of the salmon producers (in Scotland and Ireland) and the tariff are insufficient to make up for the loss of the salmon demanding industry in EU. The latter depends critically on the level of the supply elasticity of the Norwegian export. With a perfectly elastic supply of Norwegian salmon the tariff leads to a loss for the EU industry and consumers, but it may be beneficial if the Norwegian supply to the EU is sufficiently inelastic. Although the main focus for trade restrictions are protection of domestic industries, strategic trade policy issues like profit shifting measures has recently received attention as well (Brander, 1995). The simulations document that with the appropriate supply conditions, a tariff may be beneficial for the EU in total. However this do not seem to be issues in the EU-Norway salmon trade dispute, because EU seems to be willing agreeing on a trade restriction (export tariff) that does not leave EU with any tariff revenue. The export tariff would lead to a loss for the EU in general. In this sense, total economic surplus does not seem to be of major concern within EU policy. Primarily, the EU policy seems devoted to secure the economic and social welfare of the fishery dependent communities expressed in the CFP. However, the social and economic objectives can also be fulfilled by direct subsidies that expand aquacuture production in EU thereby avoiding the welfare loss of the salmon demand industry in EU.

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