A Cost-Benefit Analysis of a Public Labelling Scheme of Fish Quality

Max Nielsen
Frank Jensen
Eva Roth

January 2004

Editor: Eva Roth

Department of Environmental and Business Economics
IME WORKING PAPER 53/04

ISSN 1399-3224

Max Nielsen
Danish Research Institute of Food Economics
Rolighedsvej 25
DK-1958 Frederiksberg C
Tel.:+45 35 28 68 94
Fax: +45 35 28 68 01
E-mail: max@foi.dk

Frank Jensen and Eva Roth
Department of Environmental and Business Economics
University of Southern Denmark
Niels Bohrs Vej 9-10
DK-6700 Esbjerg
Tel.: +45 6550 4208 and +45 6550 4186
Fax: +45 6550 1091
E-mail: fje@sam.sdu.dk and er@sam.sdu.dk

Abstract

The purpose of this paper is to introduce a new method capable of evaluating the economic welfare for quality graded fish products using the hedonic price method for plaice in Denmark. Today no labelling scheme exists for the final consumers of different qualities of fish. A scheme does only exist at the first hand market. On this basis, a general applicable theoretical and empirical method is developed to compare the costs and benefits of the hypothetical choice between the total absence of labelling and the presence of a public labelling scheme, which fully inform consumers on the quality and simultaneously allow the producers to differentiate prices between quality grades. It is shown that the economic welfare associated with a public labelling scheme is at minimum 263,000 euro. Sensitivity analysis shows that this result is robust. The policy implication is that a public labelling scheme should not be implemented as the demand and cost functions have low elasticities, implying that the welfare gain is low.

Key words: Co-integration, fish quality, hedonic pricing, public labelling scheme, welfare.

JEL classifications: L11, Q21, Q22.

The authors thank Cathy Roheim and Henning P. Jørgensen for valuable comments on an earlier draft of this paper. Furthermore, we gratefully acknowledge financial support from the EU Commission under the MISSFISH Project (FAIR CT 98 4255).

Table of contents

1. Introduction 7
2. Theory 11
3. Empirical estimations 17
4. The net benefit of a public labelling program.. 23
5. Discussion 25
6. References 29

1. Introduction

The objective of the present paper is to introduce a new method for calculating the economic value of fish quality, thereby being able to evaluate the economic rational for implementing a public labelling scheme for fish quality in the retail market for plaice in Denmark. The rationale is evaluated by comparing the welfare of total absence of labelling with the welfare in the presence of a full public labelling scheme, where perfect information prevail and where producers differentiate prices accordingly. The economic welfare is calculated both with and without labelling, thereby identifying the rise in welfare associated with the introduction of labelling. This is done under two alternative assumptions on the reaction of the market. In the first case it is assumed that the price adjustment in the market remains unchanged despite the introduction of the public labelling scheme while the second case establishes a market reaction which leads to a social optimum. Thereby, a lower and an upper limit of the welfare associated with a public labelling scheme appear. Price differentiation is assumed possible only with labelling, with prices being higher for higher quality fish. Without labelling fish of all qualities are sold at the same price. The hypothesis of the paper is that the benefit of the introduction of a public labelling scheme of plaice quality is small, since demand for fish generally is inflexible to changing quantities (Nielsen (1999)). This is further underlined by the relative insignificance of supply of one country to the total market. Provided that this is the case, the costs might be larger than the benefit and the scheme should not be implemented for rational economic reasons.

The empirical analysis departs from the first-hand market for plaice in Denmark, where the European Council Directive (no. 2406 of 1996) on the common marketing standards for fish products is in force. According to this, quality grading of fish in all landing markets in the EU is obligatory. Welfare is defined as consumer and producer surplus, with and without labelling. Hence, the present quality differentiation of the first-hand market serves as an approximation of the welfare premium at the retail market. Welfare appears from estimating demand and cost functions. The demand functions for consistently aggregated plaice products are identified using co-integration, since data are non-stationary. The cost functions are identified using a simple calculation procedure. Comparing the welfare with and without a public labelling scheme identifies the welfare effects of the potential introduction of a full scheme.

The welfare calculations are based on prices in the first-hand market, implying that these are the prices the consumers pay. Hence, an implicit assumption is that trade of plaice in Denmark takes place directly between the fishermen and the final consumers or, alternatively, that a fixed mark-up in the intermediate trade equal to costs prevail in the trade. Both assumptions have a similar outcome for the economic argument and imply that fishermen earn the producer surplus, while the final consumers earn the consumer surplus. In reality, a whole supply chain is present when plaice is traded in Denmark. When the fish is caught it is most often sold through the auction system. A part of the catch of plaice is exported as fresh and chilled plaice primarily to the European market. A large part goes to fish processing factories from which it reaches the market mostly through Danish and European supermarket chains. For each supply chain in this business procedure a market exist and, thereby, a consumer and producer surplus is earned. Therefore, the calculated welfare does not include the consumer and producer surplus earned in the remaining part of the supply chain.

The issue of quality is important in fish markets, since consumers cannot necessarily distinguish quality of plaice. Although it might be possible for some consumers to distinguish quality of fresh plaice before purchase, for example through the smell, the look of the eyes and the consistency of the flesh, it is generally presumed that only some consumers have this ability. Furthermore, it is more difficult for consumers to distinguish quality of processed products, such as fillets and panned fillets, before purchase. It might be possible to distinguish the quality of these product forms during consumption, but even then it might not be the case for several consumers. Contrary, it can be argued that since fish purchase in most instances is a repeated game, the purchase of bad quality would simply lead the consumer not to abstain from further purchase but to change supplier. In other words, it is assumed that the demand function is unchanged by the experience of bad quality. This implies that consumers might be able to judge the quality during consumption. Therefore, it remains uncertain whether consumers in general actually can distinguish the quality of plaice, but since the majority of plaice landed in Denmark are sold in processed forms it is assumed throughout this paper that consumers cannot distinguish. The ability of consumers to judge quality might be decisive for whether the introduction of a public labelling scheme is relevant. If they cannot distinguish the quality, the introduction of labelling solves a potential information problem, but if they have the ability to distinguish the quality, the scheme can be considered unnecessary. However, despite their possible ability to distinguish, consumers might be interested in the introduction of the scheme, since it implies that they can be perfectly certain on the quality. Such certainty might be important for consumers due to the utility of eating fish, but also as a signal of high food safety.

The implication of consumers being unable to judge quality is that an imperfect information problem arises. This situation has similarities with the problem discussed by Akerlof (1970) in the market for lemons. In this market the producers cheat the consumers by pretending that a good of low quality has high quality. Thereby, the producers increase their profit. In this paper an imperfect information approach similar to Akerlof (1970) is used. In the case without labelling it is assumed that an expected demand curve exists. This expected demand curve is calculated from the demand curves of different qualities using probabilities for the different quality levels. Now one, and only one, price is used to calculate the expected quantity of fish that is consumed. One price for fish exists because of imperfect information. A public labelling scheme meets this information problem and distributes the fish of high quality to the consumers who prefer them. Furthermore, it can support the producers by allowing them to differentiate prices.

The issue is also interesting in relation to the choice between public and private labelling schemes in that a compulsory public labelling scheme is normally introduced for the benefits it brings to society. Contrary, it can be argued that a private labelling scheme is launched if it is profitable for the companies participating and the companies voluntarily joining the scheme. This type of labelling does not necessarily lead to the maximisation of total welfare. Instead, private labelling is meant to differentiate the market so as to differentiate the prices and transfer consumer surplus into producer surplus. Hence, if labelling shall be introduced according to a cost-benefit criteria, the welfare should necessarily include both consumer and producer surpluses and the gain to society must be higher than the costs associated with developing, monitoring and controlling the scheme. In the Nordic countries labelling schemes are most often introduced, monitored and controlled by the public.

In the economic literature, economics of information with regard to consumption have developed over several years, starting at least from Nelson (1970), who introduced “search costs“ attributable to the time and energy spend by the consumer to determine and obtain the products with the desired quality. Based on the Lancaster (1971) theory of characteristics, Nelson (1974) distinguish between search and experience characteristics of goods, where consumers can determine the properties, including quality, of a search characteristics before they buy the good, while the properties of experience characteristics are only appearing during consumption. Darni and Karni (1973) further introduce the credence characteristics, where consumers cannot determine the properties of the good at all, not even after they have consumed it. According to Caswell (1998), labelling of fish has the effect of transforming the experience and credence characteristics into search characteristics, thereby increasing welfare.

Another direction in the literature is the principal-agent approach, which is developed as a recent solution to the problems of imperfect information (Varian (1992)). This approach applies a solution of a tax/subsidy mechanism to correct the market failure that arises with imperfect information. An alternative to the principal-agent approach is labelling in the situation where imperfect and asymmetric information exists in the consumer market. The producers know the quality of the fish products whereas the consumer is uninformed and the labelling solution to this asymmetry is studied in this paper.

A few studies also identify consumers of labelling empirically. Wessels *et al.* (1999) and Pickering *et al.* (2001) estimate consumer willingness to pay for seafood labelling using stated preference methods. By focusing on consumer willingness to pay the production side of the economy is ignored. This paper applies the revealed preference method of hedonic pricing to measure consumer benefit of the quality property contrary to Wessels *et al.* (1999) and Pickering *et al.* (2001). The authors are not aware of the existence of any articles identifying the total welfare of labelling of fish products including both consumer and producers surplus. Neither are the authors aware of articles modelling market reactions on the introduction of labelling which leads to the social optimum, nor of articles using co-integration in the estimation of the demand system as the basis for welfare analysis.

The paper is outlined as follows. In section 2 a theoretical model for calculating the economic welfare of a public labelling program is presented, while demand and cost functions are estimated in section 3. Section 4 presents the results of the cost-benefit analysis and section 5 discusses the results and the implications of the findings.

2. Theory

In this section the theory behind calculating the economic value of fish quality is sketched. Within the theory of valuing the benefits of environmental goods two traditions, stated and revealed preferences, exist. Stated preference methods include contingent valuation (Mitchell and Carson (1981)) and the idea behind this method is to ask consumers to state their preferences for a non-market good using direct survey methods. Revealed preference methods include the travel cost method (McConnell (1985)) and the hedonic price method (Harrison and Rubenfeld (1978)). Travel cost methods are based on the fact that private resources are sacrificed in order to consume an environmental good. This is used to estimate a demand curve. The idea behind the hedonic method is that differences in the level of an environmental good are reflected in the price of a private good. In this paper, the hedonic price method is used, because differences in the level of fish quality are assumed reflected in the price of fish.

In the introduction it was mentioned that the purpose of the paper was to evaluate whether a public labelling scheme of fish should be implemented. Therefore, a model for the market of fish with and without a public labelling scheme is necessary. First, a model for the fish market with a public labelling scheme is introduced. Assume that trade of fish takes place directly between consumers and fishermen and three qualities of fish, s_1, s_2 and s_3, exist, where *1* express the highest quality and *3* the lowest quality. s_i for $i = 1,2$ *and* 3 is assumed to be a discrete variable. With a public labelling scheme different prices for different qualities can exist. Therefore, three different demand functions are postulated: $P_1 = f_1(q_1, s_1)$, $P_2 = f_2(q_2, s_2)$ and $P_3 = f_3(q_3, s_3)$ where P_i for i = *1, 2 and 3* is the price and q_i for $i = 1, 2$ *and* 3 is the quantity.[1] For each quality of fish a cost function, $C_i(q_i)$ for $i = 1,2$ *and* 3, is also assumed to exist. The cost function measures the opportunity cost of catching fish. A regulatory authority (society) maximises the net benefit of the fishing activity. This net benefit can be defined as:

$$Max\int_o^{q_1} f_1(q_1,s_1)dq_1 + \int_0^{q_2} f_2(q_2,s_2)dq_2 + \int_0^{q_3} f_3(q_3,s_3)dq_3 - C_1(q_1) - C_2(q_2) - C_3(q_3) \tag{1}$$

s.t.

$$q_1 + q_2 + q_3 \leq K \tag{2}$$

where K is a quota. (2) is a quota restriction expressing that the sum of catches of all qualities must not exceed the quota.

Assuming a binding quota restriction, the first-order conditions are:

1 In the theoretical model, it is assumed that the price of one quality only depends on the consumed quantity of that quality grade. In reality, fish of various qualities is substituted and in the empirical model such substitution is included. However, the possibility of substitution between qualities does not change the theoretical argument and, therefore, this possibility is excluded.

$$f_1(q_1,s_1) - MC_1 - \lambda = 0 \tag{3}$$

$$f_2(q_2,s_2) - MC_2 - \lambda = 0 \tag{4}$$

$$f_3(q_3,s_3) - MC_3 - \lambda = 0 \tag{5}$$

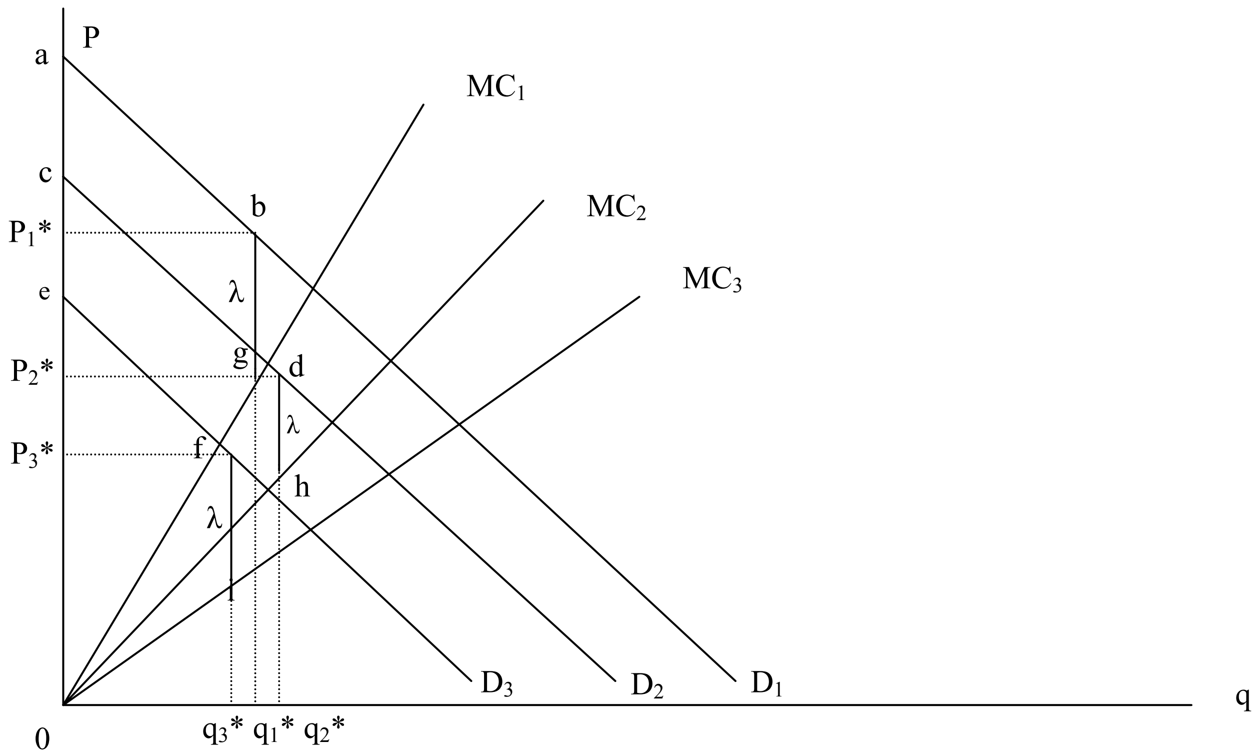
where MC_i for $i = 1,2$ *and* 3 is the marginal cost and λ is a Lagrange multiplier included due to the quota restriction. Because *1* express the highest quality and *3* the lowest quality a natural assumption is that $MC_1 > MC_2 > MC_3$. Because λ is the same for all three qualities this implies that $P_1 > P_2 > P_3$.

λ is the shadow price of the quota restriction and measures the loss in welfare of catching fish of one quality due to lost catch opportunities of other qualities. In this way λ captures the social cost of an externality, which can be labelled the quota externality. The quota externality arises because catches of fish of one quality implies a cost in terms of decreased catch possibilities of other qualities. When the quota is set in an economic optimal way the quota externality is exactly equal to what is commonly referred to as the stock externality (Clark (1991)).

Because λ is equal for all qualities, it is social optimal to select quantities such that $P_1 - MC_1 = P_2 - MC_2 = P_3 - MC_3$. Thus, the implication is that the social optimum occurs where prices are equal to a common mark-up over marginal cost. The mark-up over marginal cost reflects the cost of the quota externality (stock externality).

The social optimal solution is illustrated in figure 1.

Figure 1. The social optimal solution with labelling



The difference between the price and marginal cost must be equal to λ for all qualities. Therefore, q_1*, q_2* *and* q_3* is the social optimal quantity of fish of quality *1, 2 and 3* and P_1*, P_2* *and* P_3* is the optimal prices. The total consumer surplus for all three qualities is $abP_1* + cdP_2* + efP_3*$ while $P_1*bg0 + P_2*dh0 + P_3*fi0$ is the total producer surplus. The total welfare, assuming that a labelling scheme induces optimal quantities, is the sum of producer and consumer surplus.

However, there is no guarantee that the market will secure q_1*, q_2* *and* q_3* and the total welfare calculated in figure 1 is, therefore, an upper estimate of the welfare. A lower estimate must, therefore, also be established. In table I the actual prices of various qualities, P_1', P_2' *and* P_3', is reported. The quantities of different qualities, q_1', q_2' *and* q_3', assuming actual prices may now be found from the equations $P_1'=f_1(q_1', s_1)$, $P_2'=f_2(q_2', s_2)$ *and* $P_3'= f_3(q_3', s_3)$[i]. In addition, the marginal costs may be found by solving $MC_1'=MC_1(q_1')$, $MC_2'=$

$MC_2'(q_2')$ *and* $MC_3' = MC_3'(q_3')$. By using P_i', q_i' *and* MC_i' for $i = 1, 2$ *and* 3, consumer and producer surplus and, thereby, welfare, can be calculated assuming current prices. This can be considered as a lower estimate for the welfare achieved by a public labelling program, because an implicit assumption is that no market reaction occurs.

Now turn to the case without labelling. Consumers cannot distinguish between various qualities of fish and, therefore, one price exists in the market for fish. Assume that a probability, π_i *for* $i = 1, 2$ *and* 3 exist for consuming a fish of quality i. Now an expected market demand function can be defined as $P = m(q)$, where P is the common price and q is the aggregated output. In addition, an industry cost function can be defined as $C = C(q)$. Turn now to society's maximisation problem without labelling which can be written as:

$$Max\left(\int_0^q m(q)dq - C(q)\right) \tag{6}$$

s.t.

$$q < K \tag{7}$$

In the case of a binding quota restriction, it follows that:

$$q^* = K \tag{8}$$

(8) expresses that the quantity caught is equal to the quota.

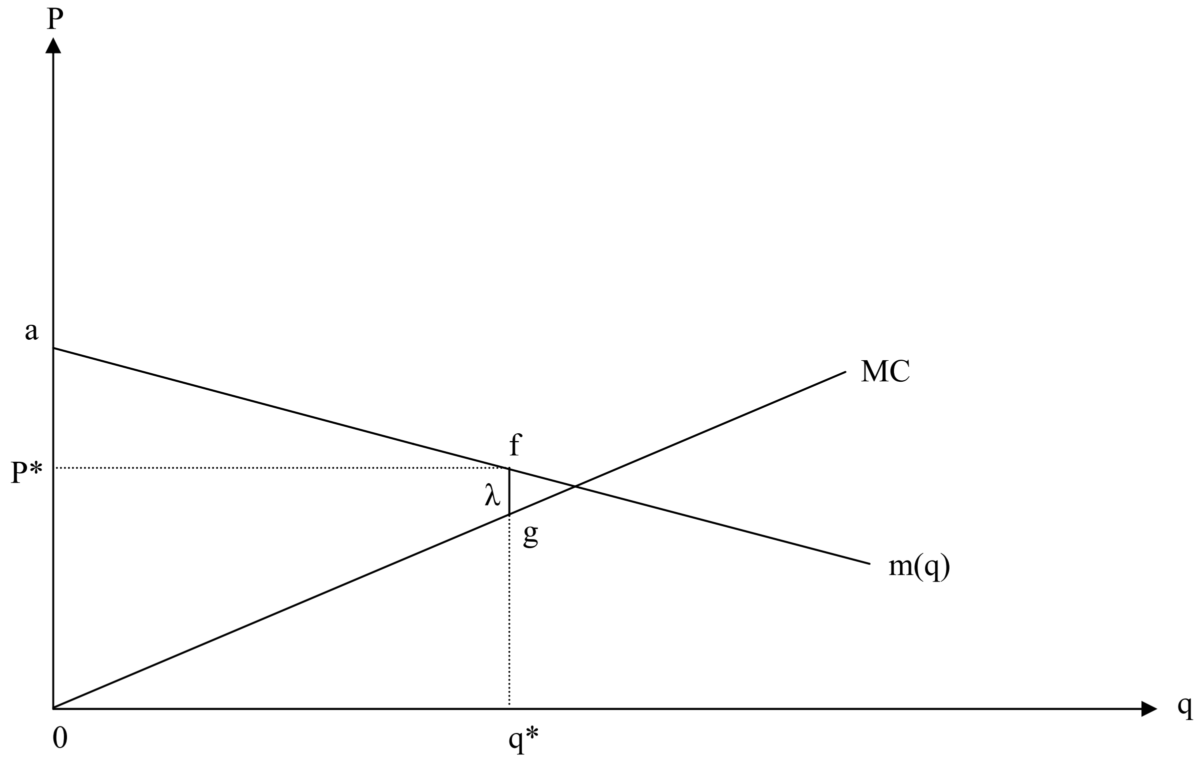
The first order condition of the maximisation problem is:

$$m(q) - MC - \lambda = 0 \tag{9}$$

λ is the shadow price for the quota restriction and express that fish caught by one fisherman has an opportunity cost in terms of lost fishing opportunities for other fishermen. In this instance, λ is again a measure of the quota externality. Because $\lambda > 0$, $P > MC$ and for the society it is again optimal to select quantities such that the prices are larger than the marginal cost. The difference between price and marginal cost reflects the quota externality and, thereby, the stock externality if the quota is set in an economic optimal way.

Figure 2 illustrates the solution.

Figure 2. Social optimum without labelling



In figure 2 the optimal quantity is q^* and this optimal quantity is equal to the quota. P^* is the optimal price and the price is larger than the marginal cost reflecting the quota externality. The total producer surplus is P^*fg0, while P^*af is the consumers surplus. The sum of producer and consumer surplus is the total welfare.

As in the case of labelling the welfare sketched in figure 2 is an upper bound for total welfare because optimal quantities are assumed. A lower bound is obtained by using the current average price, P', in table I. Now the quantities are found by the equation $P' = m(q')$ and the marginal costs by the equation $MC' = MC(q')$. On basis of P', q' and MC' a lower bound for consumer and producer surplus and, thereby, welfare can be calculated.

Irrespectively of whether current or optimal prices are used the net benefit of a public labelling program may be found. Let WUL be the economic welfare without labelling and WL the net benefit with labelling. Now $NB = WL - WUL$ is the net benefit of a public labelling program. Assume, further, that a cost of PC of implementing a public labelling program is induced to society. If $NB > PC$ the labelling program shall be implemented, while the program shall not be implemented if $PC > NB$. Such calculations will be performed in section 4 for plaice in Denmark.

3. Empirical estimations

In this section, the demand and cost functions are identified for plaice traded in the Danish market. Before that, however, data is examined.

Data on plaice landings in Denmark were obtained from the Danish Directorate of Fisheries. The data are monthly, cover the period January 1993 to December 1998 and includes both landings of domestic and foreign fishermen. The data are sorted into quality extra (E-quality), A-quality, B-quality and not admitted, in accordance with the Council Regulation (1996) laying down the common marketing standards for certain fishery products. The quality differentiation is defined for freshness and includes the colour of the skin and skin mocus, the look of the eye, gills and peritoneum (in gutted fish), the smell of gills and abdominal cavities and the consistency of the flesh.

The data are available in volume, value and average price for different quality grades. The average prices are in fixed prices corrected using the consumer price index. Data summary statistics are presented in table I as yearly averages.

Table I. Data summary statistics, yearly average, 1993-98

	Quantity /tonnes	Price /euro per kilo
Plaice:		
Grade E	7,104	1.86
Grade A	16,728	1.68
Grade B	24	1.08
Not admitted	2,172	0.40
Total	26,028	1.62

Table I shows that 92% of total landings in the 72 periods (months) are graded as E, A and B-fish. It, further, appears that two-third is graded as A-fish and that the average price increases with the level of quality as expected. The average price of the not admitted fish, however, shows huge fluctuations over time. The reason is that this grade is used as a residual where fish incorrectly graded are entered. Due to the presence of this situation, the not admitted fish are excluded from further analysis. Furthermore, the total landings of approximately 26,000 tonnes correspond to the quota, assuming perfect quota utilisation. Finally, it appears that the prices of E and A fish are relatively similar, while B-fish are cheaper.

The methodology used to identify demand functions starts with the estimation of a simple average inverse linear demand function, where the inverse form is selected since in the case of fisheries it is, according to Wilen (2000), quantity that is predetermined at the market level due to the widespread use of quantity regulation. The linear form is selected since it might be globally decreasing and have a positive intercept, implying that it is possible to calculate the consumer surplus.[2]

The regression equation for the demand function $P = m(q) = \gamma_o - \gamma_1 q$ is, however, only valid for stationary data series. A data series is stationary if it moves randomly around a constant mean over time and non-stationary if it follows a trend. A non-stationary data series is integrated of degree one, i.e. I(1), if its first differences moves randomly around a constant mean over time. For an I(1) data series the Johansen co-integration rank procedure must, therefore, be used. Hence, since all data were tested for the presence of unit roots using Augmented Dickey-Fuller tests found to be I(1), co-integration must be used. A traditional vector auto regressive model in error correction form with the constant restricted to the co-integration space and the parameter estimates unrestricted is used following e.g. Jaffry, Pascoe and Robinson (1999).

Based on the estimated average demand function, individual demand functions can be identified, provided that the prices of the different quality grades are formed within the same market. This follows from the Composite Commodity Theorem of Lewbel (1996), which states that if two or more price series can be described by the same common factor, the relative prices remain fixed and prices will move together over time. Thus, a composite commodity can be constructed. It is, however, a "reverse" use, since in a situation where the theorem is in force, the average demand function is disaggregated into three individual demand functions. This is done knowing that the individual demand curves are parallel to the average demand curve, since a price change in one of the commodities affects the quantity of the commodity in the same direction and scale. Therefore, the individual demand curves are calculated given the knowledge that they are parallel to the average demand curve with the distance between them given by the difference in average prices.

---

2 This is not the case in an Inverse Almost Ideal Demand system, since it is based on a second order approximation around the optimal point of the true preference structure (see Jensen, Nielsen and Roth (2003)).

It follows that it must be tested whether the prices of the different quality grades are formed within the same market. This is done using the Stigler (1969) definition of a market as "the area within which the price is determined, allowances being made for quality differences". The basis is the traditional test of the Law of One Price (LOP) for I(1) data, where trending prices must move perfectly together over time in order to be formed within the same market. Asche, Bremnes and Wessells (1999) provide with their model the point of departure, with the only difference being that the present estimation is with a trend term restricted to the co-integration space. The reason is that the quality which caused price differences are then also allowed to be non-stationary. Provided that the co-integration test identifies one (and only one) integrating factor which is common to all the price series and that the test of the LOP shows that the LOP is in force, prices follow each other over time and, thus, the individual demand curves are parallel to the average demand curve.

The average demand function was estimated without misspecification problems for a model with 8 lags and eleven centred seasonal dummies included. The misspecification tests included autocorrelation, normality and autoregressive conditional heteroscedasticity tests and conclusions on the absence of misspecification problems are obtained at the 5% significance level. The result of the Johansen test is reported in table II.

Table II. Johansen test with average price and quantity included

Model	H_0: rank=p	Eigenvalues	Trace test[1]	$C_{95\%}$
Period = 93.01-98.12	P=0	0.18	19.87***	19.99
Lags = 8	p<=1	0.10	6.91	9.13
11 seasonal dummies				
72 observations				

Note: 1. */*** = Significant at the 1 and 10 percent levels, according to critical values known from Johansen (1996).

It appears that a rank of one is obtained at the 10% level as required, implying that the function can be exact identified. The average demand function for plaice landed in Denmark is identified as $p = 15.8 - 0.0000011 * q$.

Given that prices of the different quality grades of plaice are formed within the same market, the individual demand functions of the different quality grades can be identified. In order to ensure that the different quality grades are formed within the same market, co-integration tests and tests of the LOP must be performed. This was done for a model with 8 lags, with a trend restricted to the co-integration space and with eleven centred seasonal dummies included. Again, the model was estimated without misspecification problems. The results appear in table III.

Table III. Multivariate Johansen test of the price series and test of the LOP

Model	H_0: rank=p	Eigenvalues	Trace test[1]	$C_{95\%}$
Period = 93.01-98.12	P=0	0.34	49.55*	42.20
Lags = 8	p<=1	0.22	23.42***	25.47
11 seasonal dummies	p<=2	0.11	7.42	12.39
72 observations				

Note: 1. See table II.

Table III shows that a rank of two was found on the 10% level between the price series for the three quality grades of plaice. The Likelihood Ratio test statistics is 7.14 and accepting a p-value of 3%, the test of the LOP was also accepted. This implies that the LOP is in force and prices of the different quality grades of plaice move together over time. Thus, prices are formed within the same perfectly integrated market and the individual demand functions can be identified. This is done knowing that the slopes are the same as the slope of the average demand function and with the differences in intercepts of the individual demand functions given by the differences between average prices. Thereby, the three individual demand functions are given by:

$$p_E = 17.6 - 0.0000011 * q_E \quad (10)$$

$$p_A = 16.2 - 0.0000011 * q_A \quad (11)$$

$$p_B = 11.8 - 0.0000011 * q_B \quad (12)$$

The estimated demand curves have, as expected, a very low elasticity.

In order to calculate the expected market demand curve, some probabilities for the various quality levels are necessary. Assume that the output shares are an estimate for these probabilities. In this case the expected demand function is given by the average demand function:

$$p = 15.8 - 0.0000011 * q \quad (13)$$

(13) has a very low elasticity.

The methodology used to identify the cost functions is based on that the costs reflect opportunity costs. This implies that the costs of an activity are the benefit loss of using the resources in an alternative way. However, assuming perfect competition in the economy the opportunity cost of fishing is exactly the costs associated with the fishing activity. This implies that the account statistics in Anon (1998) can be used to calculate the economic costs associated with fishing plaice of various qualities in Denmark. However, because account statistics are only available for five years it is impossible to estimate a cost function using econometric methods. Therefore, a method in Jensen (2002) is applied to determine a cost function. The idea in this method is to calculate a cost parameter based on information on total costs and catches of each quality.

First, it is necessary to calculate economic costs from the account statistics. The idea is to take the total expenditures for all species harvested minus depreciations. Then, assuming that the skipper has an alternative employment opportunity equal to the wage rate for employment in the fishing sector, the cost of the skipper is added to the total costs. Taking the share of plaice of the total revenue and multiplying with the total cost of all species gives the total cost of plaice. Then, total cost of various qualities of plaice is found by multiplying the total cost of plaice by the share of the quality category of output. Now the following cost functions are assumed:

$$TC_E = eq_E^{\ 2} \tag{14}$$

$$TC_A = fq_A^{\ 2} \tag{15}$$

$$TC_B = gq_B^{\ 2} \tag{16}$$

Calculation shows that e = 0.0000064, f = 0.0000018 *and* g = 0.00000099 and the hypothesis that $MC_E > MC_A > MC_B$ is confirmed.[3] The parameter estimates show that marginal cost functions is inelastic.

The total cost function for all plaice for the case without labelling is correspondingly established, but now on the basis of aggregated costs and the aggregated catches of all plaice. This market cost function is assumed given by:

$$TC = hq^2 \tag{17}$$

Where h = 0.00000018. Again the marginal cost function is inelastic.

4. The net benefit of a public labelling program

The economic welfare associated with implementing a public labelling scheme is calculated in this section on the basis of the parameters estimated in section 3, using the models of section two.[4]

With regard to social optimal prices and quantities with labelling, it turns out that the actual price for grade *E and A* is too small. It would be more beneficial

3 The background data on the calculation of the parameters in (14)-(16) are available from the corresponding author on request.

4 The equations for the social optimal quantities, prices and marginal costs as well as for the calculation of consumer and producer surpluses are derived on the based of the model in section two. These derivations are not reported, but available from the corresponding author on request.

to society to supply less of grade *E and A* and, thereby, increase the price of these two grades. With regard to grade *B* the price is too high and the quantity supplied is too small. In the case without labelling the social optimal price is larger than the actual average price. In the case of labelling λ = 0.72 euro per kilo indicate that prices are considerably higher than the marginal costs, while λ = 0,44 euro per kilo without labelling. The values of λ in the case without labelling explain why the optimal price is larger than the actual price.

With respect to the lower bound (actual prices), the quantities calculated are larger than the actual quantities and equal to the quota.

The calculated welfare is reported in table IV.

Table IV. Social welfare, euro per year

		Consumers surplus	Producers surplus	Total Welfare	Welfare Gain
Upper bound					
	With labelling	359,000	275,000	634,000	301,000
	Without labelling	206,000	127,000	333,000	
Lower bound					
	With labelling	264,000	240,000	504,000	263,000
	Without labelling	150,000	91,000	241,000	

The welfare gain obtained by introducing a public labelling program is 301,000 euro when optimal values are used and 263,000 euro when actual values are used. The difference between these numbers is not large and it is reasonable to assume that the real welfare gain lies between these numbers. Taking the lower bound as a point of departure, the distribution of the welfare gain is 114,000 euro to consumers and 149,000 euro to producers. Thus, even though both groups gain from the introduction of the public labelling scheme, the gain of producers are largest with a 165% increase compared to the producer surplus without labelling. The rise of consumer surplus compared to without labelling is

75%. However, the total welfare gain only represents 0.6% gain on total turnover of 42 million euro.

The results may be sensible to variations in the estimated parameters. Therefore, sensitivity analyses are performed. The slopes and the intercepts of the demand function for all the three quality grades as well as for the cost parameter are varied by *+/- 20%* in both the upper and lower bound. The results are not reported, but shows that when the intercepts of the demand functions are varied by +/- 20%, the welfare gains does not change with more than 6% in any of the cases. Varying the slope of the demand functions yields changes not larger than 3% and varying the cost parameter change the welfare gains by not more than 12%. Hence, the total benefit remains approximately unchanged with varying parameters when a public labelling program is considered. The welfare gains are at minimum 263,000 euro. Instigating a public labelling scheme at a cost less than the welfare gain is hardly possible and this leads to the conclusion that such a program should not be implemented. The low welfare gain appears because the cost and demand functions are inelastic.

5. Discussion

In this paper it has been shown that a public labelling scheme for plaice in the retail market of Denmark yield a benefit to society at a minimum of 263,000 euro per year. If the cost of introducing, monitoring and controlling this scheme is less than this benefit, it was found that the scheme would be a net welfare gain to society. Furthermore, it was shown that both producers and consumers would gain. The gain in producer surplus causes a market reaction induced by price differentiation. The consumer surplus increase as the consumers who prefers high quality actually also obtains this quality. The gain of producers was, however, larger than for consumers. All results were robust to changes in the parameter estimates.

The minimum benefit of 263,000 euro of introducing a public labelling scheme represents more than a doubling of welfare compared to the market situation without labelling. Compared to the gross turnover in the market of 42 million euro, however, the gain represents only 0.6%. Hence, even though the relative increase in welfare following the introduction of labelling is large, the absolute welfare both before and after the introduction of labelling as well as the welfare compared to gross turnover are small, due to inelastic supply and demand. The hypothesis of the paper is then confirmed. Therefore, despite that information on the costs of the introduction of the public labelling scheme is not available it is highly unlikely that a public labelling scheme can be set up at such low costs. This implies that a public labelling scheme according to economic arguments should not be set up.

The argument that some consumers, as opposed to the a priori assumption in the paper, might be able to distinguish quality, points in the same direction. The reason is that the introduction of a public labelling scheme might then be unnecessary for consumers. For producers, however, the option of price differentiation introduced with the labelling scheme will still result in the welfare gain. Therefore, the total welfare gain will be given only by the producer surplus and is therefore less than the gain in the case where consumers are assumed unable to judge quality. The consequence is again that a public labelling scheme, according to the cost-benefit argument, should not be set up.

The benefit of the 263,000 euro is, however, for at least three reasons a lower estimate of the true benefit. First, as explained in the theoretical section, the estimate is obtained by inserting actual prices in the demand function. Thereby, it is assumed that no market reaction to a public labelling scheme will occur. If a market reaction takes place welfare will increase. Second, behind the calculation of economic welfare is an implicit assumption that the market interactions between consumers and producers take place at the landing level. Thus, fish is directly transferred from the fisherman to the final consumer. However, the fish is traded though a supply-chain before the product reaches the final consumers and this supply chain also earns a producer and consumer surplus. Third, if a public labelling scheme is introduced for plaice it is most likely introduced for other species too. Thus, consumer and producer surplus is earned in the market for those species unless a fixed mark-up in the intermediate trade equal to costs prevail in the market. However, with respect to the public cost of labelling there are economics of scope implying that this result does not preclude an economic rational labelling scheme for the total Danish fish market.

The hedonic price method is adopted in calculating the welfare gain. This method rests on an assumption that price differentials established in the market for plaice in Denmark at first-hand-sales reveals consumer preferences. These prices reflect a non-optimal market situation because consumers have imperfect information about the quality of fish. Furthermore, a very simple linear demand system is estimated. There are two reasons for this choice. First, in order to calculate welfare, demand curves with a globally negative slope and positive intercept must be required (Jensen, Nielsen and Roth (2003)). Second, the calculation of welfare in the case of labelling is complicated even with a simple linear demand system.

An implication of the theoretical analysis is that welfare optimal prices must be higher than marginal costs with a factor that captures the value of the quota externality (stock externality). The present market allocation of the quota on different quality grades differ from the optimal allocation between different quality grades. In the actual market fishermen maximises profit and the fishery is characterised by regulated open-access (Homans and Wilen (1997)) where average revenue is set equal to average cost on the margin. Above, it was mentioned that the optimal allocation should reflect the stock externality and that the difference between price and marginal cost is equal to the value of this externality.

The results have some practical implication. The structure in determining the quality of fish in the supply chain is that fishermen a priori catch fish of excellent quality. The quality of fish is preliminary determined by how the fish is treated by the fishermen after they are harvested. Therefore, it is reasonable to operate with a cost function for each quality grade and such a cost function is analysed in this paper. In the estimation section it is shown that fish of different qualities are traded on perfectly integrated markets. In other words, the fish is traded in a market, where prices move together over time. The implication of this is that the only difference between the different quality graded demand functions is the reservation price. On the producers side of the economy a high quality implies higher marginal costs and, thus, higher price. Therefore, there is a trade-off between price, marginal costs and quality. Despite this trade-off total profit is higher for high quality because of higher willingness to pay. However, with labelling the producers will be willing to supply all quality grades of fish and will supply them until the marginal profit is equal for all quality grades. Even if a labelling scheme is introduced there are still market imperfections. Producers will still maximise profit and a stock externality remain. So despite the fact that labelling secures a welfare gain, it does not secure a welfare optimum. However, it is easy to secure a welfare optimal allocation of fish of different grades. A labelling scheme can be combined with an individual transferable quota system (ITQs). If the total quota is fixed and this total quota reflects the value of the stock externality this quota can be distributed to fishermen as ITQs. Trade among fishermen with ITQs will now occur until the marginal profit is equal between vessels and equal to the stock externality. In addition trade of ITQs among fishermen and the allocation of ITQs between grades within individual vessels will secure that the marginal profit is equal between grades.

6. References

[1] Akerlof, G. (1970): The Market for Lemons, Qualitative Uncertainty and the Market Mechanism, *Quarterly Journal of Economics*, **84**, 488-500.

[2] Anon (1998): *Account Statictics for Fishery*, Serie F, no. 4, Copenhagen.

[3] Asche, F., Bremnes, H. and Wessells, C. R. (1999): Product Aggregation, Market Integration and the Relationships between Prices: An Application to World Salmon Markets, *American Journal of Agricultural Economics*, **81**, 568-81.

[4] Caswell, J. (1998): Valuing the Benefits and Costs of Improved Food Safety and Nutrition, *The Australian Journal of Agricultural and Resource Economics*, **42**, 409-24.

[5] Clark, C.W. (1990): *Matematical Bioeconomics. The Optimal Management of Renewable Resources*, John Wiley and Sons.

[6] Council Regulation (1996): No 2406/96 of 26 November 1996 Laying down Common Marketing Standards for Certain Fishery Products.

[7] Darni, M. R., and Karni, E. (1973): Free Competition and the Optimal Amount of Fraud, *Journal of Law and Economics*, **16**, 67-88.

[8] Harrison, D. and Rubinfeld, D.L.: Hedonic Housing Prices and the Demand for Clean Air, *Journal of Environmental Economics Management*, **5**, 81-102.

[9] Homans, F.R. and Wilen, J.E. (1997): A Model of Regulated Open Access Resource Use, *Journal of Environmental Economic and Management*, **32**, 1-21.

[10] Jaffry, S., Pascoe, S. and Robinson, C. (1999): Long Run Price Flexibilities for High Valued UK Fish Species: A Co-Integration Approach, *Applied Economics*, **31**, 473-81.

[11] Jensen, F. (2002): *Essays in Management of Fisheries under Imperfect Information*, Ph.d. assessment, University of Southern Denmark.

[12] Jensen F., Nielsen, M. and Roth, E. (2003): *Application of the Inverse Almost Ideal Demand System to Welfare Analysis*, Working Paper no 43. from the University of Southern Denmark.

[13] Johansen, S. (1996): *Likelihood-Based Inference in Cointegrated Vector Autoregressive Models*, Oxford University Press, Oxford.

[14] Lancaster, K. (1971): *Consumers Demand. A New Approach*, New York: Colombia University Press.

[15] Lewbel, A. (1996): Aggregation without Separability: A Generalized Composite Commodity Theorem, *American Economic Review,* **86**, 524-61.

[16] McConnell (1985): *The Economics of Outdoor Recreation*, MacMillian: New York.

[17] Mitchell, R.C. and Carson, R.T. (1989): *Using Surveys to Value Public Goods: The Contingent Valuation Method*, Washington.

[18] Nielsen, M. (1999): *EU Seafood Markets – Integration and Demand,* Working Paper no. 13, Danish Institute of Agricultural and Fisheries Economics.

[19] Nelson, P. (1970): Information and Consumer Behaviour, *Journal of Political Economy*, **78**, 311-29.

[20] Nelson, P. (1974): Advertising as Information, *Journal of Political Economy*, **81**, 729-54.

[21] Pickering, H. (ed.) (2001): *Market-Driven Incentive Structures for Sustainable Fisheries Management*, FAIR CT98 4255.

[22] Stigler, G. J. (1969): *The Theory of Price*, London, MacMillan.

[23] Varian, H.R. (1992): *Microeconomic Analysis*, New York: Norton.

[24] Wessels, C.R., Donath, H. and Johnston, R. (1999): *US Consumer Preferences for Ecolabeled Seafood: Results of a Survey*, RI Agricultural Experiment and RI Sea Grant Publication.

[25] Wilen, J. E. (2000): Renewable Resource Economists and Policy: What Differences Have We Made? *Journal of Environmental Economics and Management*, **39**, 306-327.

Department of Environmental and Business Economics
Institut for Miljø- og Erhvervsøkonomi (IME)

IME WORKING PAPERS

ISSN: 1399-3224

Issued working papers from IME
Udgivne arbejdspapirer fra IME

No.		
1/99	Frank Jensen Niels Vestergaard Hans Frost	*Asymmetrisk information og regulering af forurening*
2/99	Finn Olesen	*Monetær integration i EU*
3/99	Frank Jensen Niels Vestergaard	*Regulation of Renewable Resources in Federal Systems: The Case of Fishery in the EU*
4/99	Villy Søgaard	*The Development of Organic Farming in Europe*
5/99	Teit Lüthje Finn Olesen	*EU som handelsskabende faktor?*
6/99	Carsten Lynge Jensen	*A Critical Review of the Common Fisheries Policy*
7/00	Carsten Lynge Jensen	*Output Substitution in a Regulated Fishery*
8/00	Finn Olesen	*Jørgen Henrik Gelting – En betydende dansk keynesianer*
9/00	Frank Jensen Niels Vestergaard	*Moral Hazard Problems in Fisheries Regulation: The Case of Illegal Landings*
10/00	Finn Olesen	*Moral, etik og økonomi*
11/00	Birgit Nahrstedt	*Legal Aspect of Border Commuting in the Danish-German Border Region*
12/00	Finn Olesen	*Om Økonomi, matematik og videnskabelighed - et bud på provokation*

13/00	Finn Olesen Jørgen Drud Hansen	*European Integration: Some stylised facts*
14/01	Lone Grønbæk	*Fishery Economics and Game Theory*
15/01	Finn Olesen	*Jørgen Pedersen on fiscal policy - A note*
16/01	Frank Jensen	*A Critical Review of the Fisheries Policy: Total Allowable Catches and Rations for Cod in the North Sea*
17/01	Urs Steiner Brandt	*Are uniform solutions focal? The case of international environmental agreements*
18/01	Urs Steiner Brandt	*Group Uniform Solutions*
19/01	Frank Jensen	*Prices versus Quantities for Common Pool Resources*
20/01	Urs Steiner Brandt	*Uniform Reductions are not that Bad*
21/01	Finn Olesen Frank Jensen	*A note on Marx*
22/01	Urs Steiner Brandt Gert Tinggaard Svendsen	*Hot air in Kyoto, cold air in The Hague*
23/01	Finn Olesen	*Den marginalistiske revolution: En dansk spire der ikke slog rod?*
24/01	Tommy Poulsen	*Skattekonkurrence og EU's skattestruktur*
25/01	Knud Sinding	*Environmental Management Systems as Sources of Competitive Advantage*
26/01	Finn Olesen	*On Machinery. Tog Ricardo fejl?*
27/01	Finn Olesen	*Ernst Brandes: Samfundsspørgsmaal - en kritik af Malthus og Ricardo*
28/01	Henrik Herlau Helge Tetzschner	*Securing Knowledge Assets in the Early Phase of Innovation*
29/02	Finn Olesen	*Økonomisk teorihistorie* *Overflødig information eller brugbar ballast?*
30/02	Finn Olesen	*Om god økonomisk metode* *– beskrivelse af et lukket eller et åbent socialt system?*
31/02	Lone Grønbæk Kronbak	*The Dynamics of an Open Access: The case of the Baltic Sea Cod Fishery - A Strategic Approach -*

32/02	Niels Vestergaard Dale Squires Frank Jensen Jesper Levring Andersen	*Technical Efficiency of the Danish Trawl fleet: Are the Industrial Vessels Better Than Others?*
33/02	Birgit Nahrstedt Henning P. Jørgensen Ayoe Hoff	*Estimation of Production Functions on Fishery: A Danish Survey*
34/02	Hans Jørgen Skriver	*Organisationskulturens betydning for vidensdelingen mellem daginstitutionsledere i Varde Kommune*
35/02	Urs Steiner Brandt Gert Tinggaard Svendsen	*Rent-seeking and grandfathering: The case of GHG trade in the EU*
36/02	Philip Peck Knud Sinding	*Environmental and Social Disclosure and Data-Richness in the Mining Industry*
37/03	Urs Steiner Brandt Gert Tinggaard Svendsen	*Fighting windmills? EU industrial interests and global climate negotiations*
38/03	Finn Olesen	*Ivar Jantzen – ingeniøren, som beskæftigede sig med økonomi*
39/03	Finn Olesen	*Jens Warming: den miskendte økonom*
40/03	Urs Steiner Brandt	*Unilateral actions, the case of international environmental problems*
41/03	Finn Olesen	*Isi Grünbaum: den politiske økonom*
42/03	Urs Steiner Brandt Gert Tinggaard Svendsen	*Hot Air as an Implicit Side Payment Arrangement: Could a Hot Air Provision have Saved the Kyoto-Agreement?*
43/03	Frank Jensen Max Nielsen Eva Roth	*Application of the Inverse Almost Ideal Demand System to Welfare Analysis*
44/03	Finn Olesen	*Rudolf Christiani – en interessant rigsdagsmand?*
45/03	Finn Olesen	*Kjeld Philip – en økonom som også blev politiker*
46/03	Urs Steiner Brandt Gert Tinggaard Svendsen	*Bureaucratic Rent-Seeking in the European Union*
47/03	Bodil Stilling Blichfeldt	*Unmanageable Tourism Destination Brands?*

48/03	Eva Roth Susanne Jensen	*Impact of recreational fishery on the formal Danish economy*
49/03	Helge Tetzschner Henrik Herlau	*Innovation and social entrepreneurship in tourism - A potential for local business development?*
50/03	Lone Grønbæk Kronbak Marko Lindroos	*An Enforcement-Coalition Model: Fishermen and Authorities forming Coalitions*
51/03	Urs Steiner Brandt Gert Tinggaard Svendsen	*The Political Economy of Climate Change Policy in the EU: Auction and Grandfathering*
52/03	Tipparat Pongthanapanich	*Review of Mathematical Programming for Coastal Land Use Optimization*
53/04	Max Nielsen Frank Jensen Eva Roth	*A Cost-Benefit Analysis of a Public Labelling Scheme of Fish Quality*